Six-pounder Rapid-Firing Gun for the British Navy.

CONSTRUCTED AT THE HOTCHKISS ORDNANCE WORKS, PARIS.

THE important order for single-barrel machine guns recently given by the British Government to Mr. Hotchkiss, is the result of the competitive trials carried out last year by the Ordnance Committee at Shoeburyness. The first Hotchkiss single-barrel machine gun was made in 1876, and this, which is now in the museum of the Hotchkiss Ordnance Works, is on the bolt principle, with an automatic feeding arrangement, exactly like the Hotchkiss revolving cannon of 1½ in. calibre, and fires the same ammunition.

After this gun was completed, a Russian inventor, Baranowsky, was killed by one of his guns, a few of which were in the Russian service during the last Russo-Turkish war. The Baranowsky gun was also on the bolt system, and the manner in which the accident took place, convinced Mr. Hotchkiss that nothing but a wedge action would give absolute security against similar mishaps in single-barrel machine guns. He therefore abandoned the idea of the bolt, and in 1879 commenced work on a wedge-action gun. In 1880 four such guns of 1.64 in. calibre were made and sold as yacht guns. Here the wedge was arranged to move horizontally, the movement of a side lever opened the wedge for loading, cocked the hammer and extracted the empty cartridge case; the loading was performed by hand. This, as well as the first-described gun, was mounted to be fired without recoil, and laid by means of a stock.

To work rapidly three men were required for the gun, viz., one to open and close the breech, one to load, and a third to sight and fire. Experience soon taught that the three men did not generally work in harmony, and the rapidity of fire was therefore not so great as required; thereupon Hotchkiss set about to alter the breech action, so that it might be worked easily by two men. The first gun of the present type, with a vertically sliding wedge, was made and tried in 1881; its calibre was 1.85 in. but later it was bored up to 2 in. and chambered to take the ammunition of the 2 in. revolving cannon. This gun is still in the hands of the Ordnance committee at Shoeburyness.

In 1881, it was decided by the War Department to invite inventors to supply a new gun for the light armament of our Navy, and the following memorandum of conditions to guide manufacturers was issued by the War Office, dated December 29, 1881.

Quick Firing Rifled Breechloading Gun for Auxilary Armaments.

1. The gun to be a breechloader which will range with accuracy to 4000 yards.

2. The muzzle velocity of the projectile to be not less than 1800 f. s.

3. The projectile to be shell and steel shot of 6 lb. weight.

4. The projectile and powder charges to be made up in one cartridge for simultaneous loading.

5. The service of the gun to be capable of being performed by three men.

6. The gun to be able to fire under the above conditions not less than twelve aimed rounds per minute,

7. The mounting to be suitable for either ship or boat service. An alternative mounting to be provided to enable the gun to be readily mounted for field service.

8. To be capable of readily delivering an all-round fire.

9. The recoil to be reduced to the lowest limits, and the gun to return after recoil to the firing position.

10. The gun to be provided with an easy removable shield, proof against the fire of the Martini-Henry rifle at 100 yards range.

11. The total weight of the gun and ship mounting not to exceed 10 cwt.

In the spring of 1883, three different guns constructed to fulfill, as nearly as possible, the above conditions, were delivered for trial by the following firms. Sir William Armstrong, Michell, and Co., Hotchkiss and Co., and Thorstein Nordenfelt.

The Armstrong gun was withdrawn from trial after the preliminary experiments, as it did not give the expected results, the Ordnance Committee recommending the Hotchkiss gun, after a series of very successful experiments at Shoeburyness. There being, however, some diversity of opinion in the Navy on the system of training the guns, the Admiralty decided to order, besides the Hotchkiss gun a certain number of Mr. Nordenfelt, who was to adopt the Hotchkiss non-recoil system of mounting, and to embody similar ballistical features in his gun, so that the ammunition could be fired from either system with exactly similar ballastical results. The exact shape of the pedestal for the guns is not yet decided, it will vary somewhat according to the construction of the ships and the places for the guns. The first 77 Hotchkiss guns ordered, are, according to the term of the contract, to be delivered by Hotchkiss and Co., by the beginning of April next.

SIX-POUNDER RAPID-FIRING GUN FOR THE BRITISH NAVY.

The Hotchkiss guns are called "non-recoil" because they are generally mounted on fixed elastic pivots and have no perceptible recoil, although the guns in reality have a definite amount of movement at the departure of the projectile, sufficient to relieve the mountings of undue shock.

In all cases, except for the larger calibres for boat service and for the field, these guns are laid by means of a stock, or shoulder-piece, bearing against the left shoulder (as in the Hotchkiss revolving cannon) and a pistol-grip with trigger, which the gunner grasps with his right hand. He fires the moment his sights bear upon the object aimed at, by pulling the trigger, so that it will be seen that this gun has the general characteristics of the Hotchkiss mounting, viz.:

1. The gun is mounted on a pivot and trained direct by the shoulder without the aid of any elevating or directing mechanism; thus en-

abling it to be pointed easily and rapidly from moving and rolling vessels against swiftly moving objects.

2. The sighting and firing are effected by a single man, which is shown in perspective above.

The gun is made of Whitworth's fluid-pressed steel, oil tempered. The body consists of a tube, and a jacket carrying the breech and the trunnions, so that the longitudinal and transverse strains are divided. The jacket is shrunk over the tube, and to prevent any slipping, they are locked together by a screwed collar, carrying the fore sight. The gun is exactly balanced in the trunnions.

Breech Action.—The breech action belongs to the class of guns with a breech-block sliding vertically through a mortice, and actuated by a lever, the movement of which opens the breech, extracts the fired cartridge case, and cocks the hammer for the next shot. The action is composed of the following parts, viz.: the wedge, with its stop-screw for limiting the run; crank and crank-handle, for moving the wedge up and down; firing-hammer and its rocking shaft; main-spring, trigger sear, trigger spring, and trigger, and the extractor.

Wedge.—The wedge A (Figs. 2 and 5) is square, with rounded corners; its face is normal to the bore, whilst its back surface is inclined. This wedge runs in guides B B (Fig. 1) on each side, and its run is limited by the stop-screw *b*, which serves at the same time to fix the stock. The wedge is moved up and down by means of the crank C, the pin *c* of which runs in a peculiarly shaped groove D (Fig. 4) in the wedge. This crank C is journalled in the right-hand cheek of the breech, and it carries on its stem the crank-handle E E^1, which serves to open the breech by pulling the top handle E, and to close the same by pulling the bottom handle E^1. This arrangement makes the opening and closing of the breech very easy and rapid.

Firing Mechanism.—The firing mechanism is placed in the hollow of the wedge and consists of a hammer F (Fig. 5,) the point of which penetrates the face of the wedge and strikes the cap in the base of the cartridge on pulling the trigger. This hammer F is mounted on a rocking shaft G which is provided with an arm *g* on the outside of the wedge.

The crank-handle E E^1 carries a cocking cam *e*, which acts on the arm *g* of the rocking shaft, and in this manner, by swinging the crank-handle downwards, the hammer is drawn backwards, or cocked, before the wedge descends to open the breech. There is a cock-notch on the hammer, and a trigger sear H (Fig. 5) catches on this cock-notch and holds the hammer back until released by pulling the trigger, which in turn actuates the trigger sear H.

The V shaped main-spring I acts direct upon the hammer, and by an ingenious arrangement both branches of it are made to work, the upper branch bearing against the heel of the hammer, whilst the lower one pulls on the opposite side, thus causing a nearly frictionless rotation of the hammer F and its axis, in the bearing.

Cartridge Extractor.—The extractor L is a prismatical piece of steel; it works in a recess on the interior left cheek of the breech and parallel to the bore of the gun; its further end forms the hook which acts on the head of the cartridge. On the same side as the hook, the extractor bears a stud *l*, which runs in a groove M on the left side of the wedge. On opening the breech the stud *l* of the extractor runs in the straight portion of the groove, which moves it backwards slowly, but as soon as the wedge is so far withdrawn that the opening N coincides with the chamber, the inclined portion of the groove acts upon the stud and causes the extractor to be moved back quickly, thus throwing the cartridge clean out of the gun.

Stock.—The stock consists of the gun-metal part O, which is attached to the left side of the breech of the gun by the screw P and the stop-screw *b*. The stock can be removed by turning the screws P and *b* a quarter of a turn. The vertical portion of the stock, which bears against the shoulder is of wood, and to prevent the shock of discharge being felt by the gunner, there is a stout india-rubber tube *r* attached to the back of the top branch. This forms a very elastic and effective buffer. The lower branch has three handles R, R^1, and R^2. The gunner grasps the handle convenient to him with the left hand whilst he bears his shoulder on the top branch and has the pistol-grip in his right, and so directs the gun.

To prevent the fired cartridge cases falling on the feet of the gunners when extracted, there is a deflector *o* attached to the gun-metal part of the stock behind the axis of the gun, against which the fired cases strike when ejected from the breech, and they drop down to the ground out of the way of the gunners.

Pistol-Grip.—The pistol-grip A is of gun-metal and is screwed on to the under side of the breech; it carries the trigger *q*, which in turn acts upon the trigger sear H in the wedge, when this is closed and the gun ready for fire.

Sights.—The front sight is a plain roughened steel point, screwed into the locking collar on the gun. The rear sight is a tangent bar sight of gun-metal, with a sliding leaf, worked by a set screw for correcting the deflection. It is moved up and down by a rack cut in the bar, and a pinion wheel, provided with a T handle. To set the sight permanently, if necessary, there is a clamp screw with the milled head. The sight is graduated in yards.

The mechanism acts in the following manner, supposing the gun just to have been fired:

First Movement.—The breech is opened by pulling the handle E. The crank-pin *c* moves backward in the groove D, part of which is concentric to the axis of the crank, and does not yet move the wedge; during this time the cocking cam *e* acts on the arm *g* of the rocking shaft, and cocks the firing hammer F. As soon as the crank-pin *c* runs in the portion of the groove D, which is inclined against the axis of the crank, the wedge is caused to move downwards, and the extractor stud l^1 being engaged in the straight part of the extracting groove M, a slight but powerful backward motion of the extractor takes place, until the wedge is drawn down so far that the opening N nearly coincides with the chamber; then the sharply inclined portion of the extracting groove acts on the stud and causes the extractor to jerk backwards and throw the fired cartridge case out of the gun. By this time the wedge is stopped by the stop-screw *b*.

Now the gun is ready to be loaded.

Second Movement.—A cartridge is run into the chamber so far until it is stopped by the rim catching against the extractor hook; now the lower crank-handle E^1 is pulled, the wedge begins to move upwards, and the inclined part of the opening N on the face of the wedge, acting on the cartridge, forces it further into the chamber; by the time the wedge is entirely closed its face bears tight up against the head of the cartridge, and the crank C has passed the vertical position and rests against the body of the gun, so that the wedge is blocked by the action of its weight, and the reaction of the crank-handle E on the discharge of the gun. When the breech is closed the cocking cam *e* on the crank-handle is in position to allow the arm *g*, and with it the firing-hammer, to act, and the gun is ready for fire.

Third Movement.—On pulling the trigger the top branch of it acts upon the trigger sear H, presses this down, and so releases the hammer, which flies forward under the action of the main-spring, strikes the primer in the cartridge, and discharges the gun.

The gun is worked by two men, one to load and one to operate the breech and fire. The rapidity of fire, with careful aiming, was found to be, at Shoeburyness, about thirteen rounds per minute.

Ammunition.—The ammunition consists of a center-fire metallic cartridge of special construction, holding in each one the powder, the projectile, and the primer, arranged in a similar manner to the metallic ammunition generally used for small arms (Fig. 12.)

Three different types of projectiles are used with the Hotchkiss guns, viz.:

a. Common shell.
b. Steel shell.
c. Canister shot.

Cartridge Case.—The metallic cartridge case consists of a drawn brass tube M, slightly conical. It is reinforced at the base by an inside and outside cup of the same metal. The head P, of iron, is dipped whilst hot in boiling linseed oil to prevent rust, and fastened to the body with brass rivets *o o*, which pass through it, and through the base and reinforcing cups, thus holding the whole solidly together. The advantage of this construction having three thicknesses of metal at the base is: that if one or the other part of the base should have unseen defects there can be no danger of leakage, as the others have sufficient strength to resist the pressure.

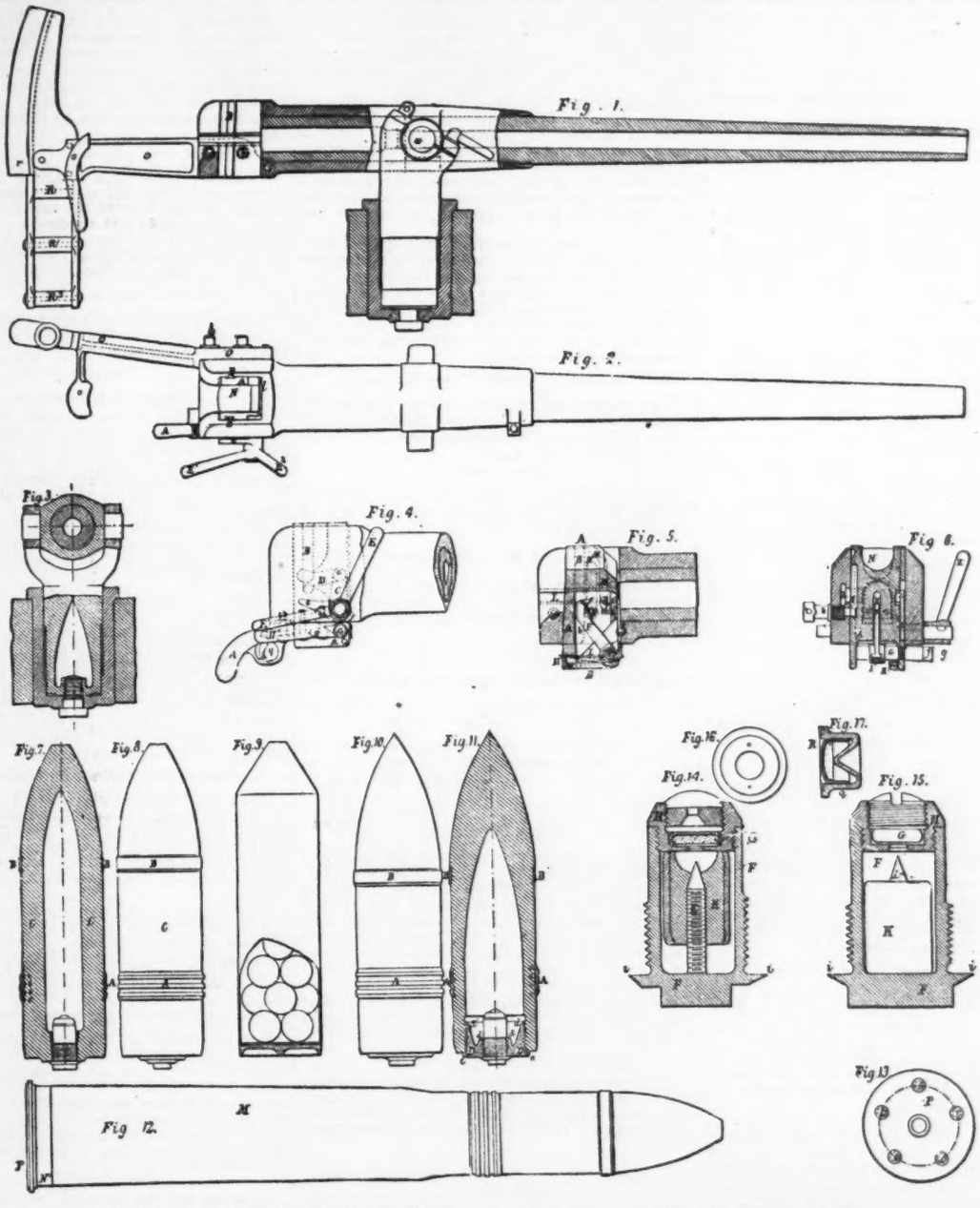
The primer consists of a small brass case (Fig. 17,) shaped to form the anvil; it is closed at the bottom end by a cap R holding the fulminate. The primer is forced into a hole which penetrates the head and the base of the cartridge, and it projects through into the inside. The reinforcing cups are pushed up around the primer cavity, so as to form a gas-check around the primer, and so hold it tight and prevent leakage.

Common Shell.—The shell differs from these projectiles commonly used, in the fact of the fuze being placed in the base instead of in the point. This arrangement gives greater strength to the point of the shell, and obviates misfires of the bursting charge, caused by the fuzes placed in the point getting damaged and broken when the projectile strikes. The shell is of cast-iron, cylindro-ogival in shape, about 4 calibres in length, and it receives its rotation by the lands of the poly-groove rifling cutting their way into the soft guiding band A, which is placed at about one calibre's distance from the base of the projectile. At the front end there is a narrow centring band B, which does not take the rifling.

The guiding bands are of soft brass contracted over the body C of the projectile. Under the rear band there are a number of grooves *c c* (Fig. 7) turned into the body, and the band is moulded into these grooves, thus leaving a small cannelured surface to take the rifling, and reducing to a minimum the strain and friction caused by the projectile passing through the bore.

The projectiles are turned smooth all over and are made with the greatest care and exactness.

Steel Shell.—This projectile is necessary so as to obtain the full perforative power of the gun, as hardened steel projectiles alone can cope successfully with modern steel or compound armour plates. The steel shell is pointed, and is fitted with the Hotchkiss base percussion fuze. It is made of special steel, of great longitudinal strength, to obtain a maximum of perforating power, and small transversal resistance, so as to enable it to explode with a relatively small charge of ordinary gunpowder. It is hardened: the hardening gradually dying away towards the base. To further facilitate the proper bursting and breaking up of this projectile it is bored equally large at the base as it is in the powder chamber, and the bore is closed by a threaded gas-check base D (Fig. 11), or fuze receiver, of



SIX-POUNDER RAPID-FIRING GUN FOR THE BRITISH NAVY,

extremely soft steel, into which the fuze is screwed.

To prevent this base being blown out of the body, and again to prevent the fuze being blown out of the base on ignition of the bursting charge, it is shaped so as to provide inwardly extending walls d d^1 forming a gas-check both around the fuze and in the powder chamber. Thus the internal pressure causes the whole to be held securely together and gas escape prevented, so that the bursting of the shell is made certain, even when striking very thin plates, wood, or any other object.

The gas-check base, or fuze receiver D, is provided with a projecting flange e, bearing against the base of the shell, which serves to close the chambers of the same effectually, by means of the external pressure on the base of the projectile when the gun is discharged, thus making premature explosions in the bore impossible.

The Base Percussion Fuze.—This fuze consists of three principal parts, viz.: The fuze case, the plunger carrying the firing pin, and the detonating cap (Fig. 14).

The fuze case F is of gun-metal, and carries the detonating composition G in the screw-cap H, which closes the end of the case. The base of the fuze is provided with a protecting flange i, brought up to a thin edge and acting as a gas-check when the fuze is screwed into the base of the projectile, because the pressure of the powder gas in the bore of the gun tends to force this flange against the base, and so make an absolutely gas-tight joint.

The plunger K is composed of a body of lead, cast into a cylindrical case of hard brass, and of the central firing-pin L made of hard brass wire and roughened so as to give sufficient hold to the surrounding lead; in order to prevent any accidental displacement. The rear end of the firing-pin projects beyond the bottom of the plunger K, whilst its front end is sunk a little below the surface. The entire length of this compound part being so calculated that when it is inserted in the fuze case, and the screw cap H is in its place, the point of the firing-pin L cannot touch the primer G, and it can only displace itself by the shock of the discharge, when in consequence of its inertia it slides back on the firing-pin down to the bottom of the case. The point then stands above the body of the plunger, ready to be projected against the detonating cap by its momentum, as soon as the flight of the projectile is retarded on striking.

The Operation of the Fuze is thus:—On the discharge of the gun, the plunger K, through its inertia, slides backwards on the firing-pin L. The lead, being a soft substance, is compressed by the shock and closes tightly on to the firing-pin again, leaving the point projecting in front. The plunger is now disengaged, and free to move forward in the line of its axis. When the flight of the projectile is suddenly retarded by its striking any object, the plunger again, in consequence of its momentum, is driven forwards, and the firing-pin strikes the detonating composition G in the front of the fuze, and ignites the bursting charge in the projectile.

This base fuze is absolutely safe during transport and all the manipulations of the projectile, as it requires the shock of the discharge to prepare it to act, and the sudden retardation in the flight of the projectile to set it off.

Canister Shot.—The canister does not much differ from that generally used with other

guns. It consists of a drawn brass case, closed at both ends, and filled with hardened leaden bullets. The front end is coned off to facilitate rapid loading. The base of the canister by means of the annular projection of soft lead, which closes the bottom, is made to form a gas-check in the bore of the gun (Fig. 9)

Principal Weights, Dimensions, Etc.

Gun.

Calibre		57 mm.	2.244 in.
Length of bore		2280 "	7 ft. 5.7 in.
" in calibres		40	
Rifling	Number of grooves	24	
	Width of lands	2 mm.	0.078 in.
	Depth of grooves	0.4 "	0.0157 "
	Twist, increasing	1 to 6 deg.	
Length of gun		2480 mm.	8 ft. 1.6 in.
" including stock		3000 "	9 ft. 10.1 in.
Weight of gun		370 kil.	7.03 cwt.
Weight of pivot		115 "	2 18 "
Weight of elastic pedestal		320 "	6.08 "

Ammunition.

Weight of common shell, charged and fuzed	2.720 kil.	6 lb.
Bursting charge	85 gr.	2.97 oz.
Weight of steel shell	2.720 kil.	6 lb.
Bursting charge	115 gr.	4.02 oz.
Weight of canister shot	3.400 kil.	7 lb. 7 oz.
Length of projectile	220 mm.	8.66 in.
Total length of cartridge with projectile	481 "	22.9 in.
Total weight of complete cartridge	4.23 kil.	9 lb. 5.2 oz.
Charge of powder	850 gr.	29.75 oz.
Initial velocity of the projectile	560 met.	1819 ft.
Total muzzle energy of the projectile	43.48 met. tns.	140.4 ft. tns.

—*Engineering.*

General Specifications for Ordinary Railroad Bridges.*

BY J. A. L. WADDELL, C. E., B. A. SC., MA. E.

The following specifications, which are preliminary to a paper upon "A System of Designing Railroad Bridges," will, in the opinion of the writer, prove to be useful to railroad engineers, particularly to those who have not made a special study of bridge work.

As is implied in the heading, they are intended for ordinary railroad bridges, more especially the Pratt and Linville trusses, but the general principles upon which they are based are applicable to all iron railroad bridges, being in accordance with the writer's previous papers upon the subjects of bridges. The parts relating to the tests of materials are upon the authority of Prof. Bovey, C. E., M. A., of McGill University, Montreal, and those relating to the intensity of wind pressure upon that of C. Shaler Smith, C. E.

SPECIFICATIONS.—*Live Load.*

The live load for single track bridges is to consist of two of the heaviest engines that, in all probability, would ever pass over the road, fully equipped with coal and water, and followed by a train of the most heavily loaded cars that would ever be allowed on the track. For double track bridges two such trains are to form the live load.

For facilitating calculation of stresses in spans of one hundred feet and under, and in track stringers and floor beams, tables of equivalent uniformly distributed loads may be prepared for all spans from five to one hundred feet in length, varying by lengths of five feet, the tabulated loads being such as to give bending moments on track stringers, plate girders and trusses, and panel loads on trusses no less than those, which would actually exist with the maximum engine loads. In spans above one hundred feet in length the chord stress in each panel is to be determined for a moving load covering the whole span, and the center of gravity of the engine excess at the panel considered.

The moving load stresses in track stringers and floor beams are to be increased by twenty-five per cent. of their amounts and the stresses due to dead load added thereto in determining the sections.

Dead Load.

The dead load is to include the weight of all the iron and wood in the structure, excepting those portions resting directly on the abutments, and whose weights do not affect the stresses in the trusses.

Pine lumber is assumed to weigh two and a half ($2\frac{1}{2}$) lbs. per ft. b. m., and oak lumber four and a third ($4\frac{1}{3}$) lbs. per ft. b. m.

Should, in any bridge of or below two hundred (200) feet span, the calculated dead load differ more than seven (7) per cent., or in any bridge above two hundred (200) feet span, more than four (4) per cent., from that assumed, the calculations of stresses, etc., are to be made again with a new assumed dead load.

Wind Pressure.

The wind pressure per square foot is to be divided into two parts, one a moving load of three hundred (300) pounds per lineal foot, and the other a fixed load of thirty pounds per square foot of exposed bridge surface.

The latter is to be determined by adding together the area of the elevation of the floor system, figured by multiplying the vertical distance from the top of the rail to the bottom of the track stringer by the length of the span, and twice the sum of the area of one truss and the area of the rectangles described about the ends of all the floor beams on one side of the bridge.

Trusses of less than two hundred (200) feet span are also to be proportioned for a pressure of fifty (50) pounds per square foot when unloaded, the area subject to wind pressure being figured as first mentioned, and the greatest stress by either method of computation shall in such case be used in determining the sectional area of the bracing.

Trusses for Double Track Bridges.

Two trusses only are to be used for double-track bridges, as intermediate trusses necessitate a spreading of the tracks, and are otherwise objectionable.

Clear Roadway.

There must be a clear roadway between trusses of fourteen (14) feet for single and twenty-five (25) feet for double-track bridges.

Limiting Lengths of Span for Different Widths.

The maximum lengths of span for the different widths measured from center to center of trusses are to be taken from the following table:

Width C. to C. of Trusses.	Maximum Length of Span.
15'	100'
16'	220'
17'	260'
18'	300'
19'	340'
20'	380'

Clear Headway.

The clear headway or vertical distance between the upper surface of the rails and the lower part of the overhead bracing shall be such as to give a clearance of six and a half ($6\frac{1}{2}$) feet between the top of the highest car and the bottom of the overhead bracing, in order to avoid danger to the brakemen.

Plate Girders and Pony Trusses.

All spans below forty-five (45) feet shall consist of plate girders, and the maximum length of pony trusses shall be seventy five (75) feet.

Limiting Depth of Pony Trusses.

The greatest allowable depth measured from center to center of chords for pony trusses, without side bracing, is to be six (6) feet, and that for pony trusses with side bracing nine (9) feet.

Limiting Slope for Batter Braces of Pony Trusses.

The least allowable slope for batter braces of pony trusses is to be two (2) horizontal to one (1) vertical.

Limiting Length of Span for Double Intersection Bridges.

The least allowable length of span for double intersection trusses is one hundred and sixty (160) feet for single and one hundred and forty (140) feet for double-track bridges.

Side Braces.

The least allowable batter for side braces in pony trusses is five (5) inches to the foot; and all side braces are to be made to resist both tension and compression. In no case are they to have less strength than that of a $2\frac{1}{2}'' \times 2\frac{1}{2}''$ —5 lbs. angle iron.

Limiting Sizes of Sections.

No round rods less than one (1) inch in diameter, nor square one less than seven-eighths ($\frac{7}{8}$) of an inch are to be used, nor channels less than five (5) inches deep. No bars less than five-eighths ($\frac{5}{8}$) of an inch thick are to be used for diagonals, nor any iron less than one-quarter ($\frac{1}{4}$) of an inch in thickness anywhere in a bridge.

Expansion.

All spans shall be provided with some means of expanding or contracting longitudinally with the variations in temperature, as must also the track stringers where they rest upon the piers or abutments.

Anchorage.

At least one end of every span must be anchored to the foundations. If the overturning moment of the greatest assumed wind pressure be more than half the resisting moment of the weight of the bridge, the latter must be anchored at the roller end also, but in such a manner as not to interfere with the expansion.

Sliding.

At the roller end of a bridge, if the frictional resistance to the sliding of the shoe in the direction of the length of the rollers be not more than double the tendency to slide, produced by the wind pressure, a resistance equal to the difference of these two quantities with a factor of safety of two (2) must be provided.

Continuous Spans.

Except in the case of swing bridges, consecutive spans are not to be made continuous over the points of support.

Camber.

The camber of all bridges of one hundred (100) feet span and over must be such that when they are subjected to their heaviest loads, the middle point of the centre line of the bottom chord shall be at least one inch above the line joining the centres of end pins, in order to provide for the case of an unequal heating of the chords.

For pony trusses one-quarter ($\frac{1}{4}$) of an inch, and for through spans less than one hundred (100) feet, half an inch of residual camber will be sufficient.

Vertical Sway Bracing.

In all deck bridges and in all through bridges, where the depth from centre to centre of chords is twenty-eight (28) feet or over, vertical sway bracing is to be used, and is to be proportioned so as to carry all the wind pressure concentrated at the upper and intermediate panel points (if there be intermediate struts) on the windward side and at the upper panel point on the leeward side.

Portal Bracing and Lateral Struts.

The portal bracing and lateral struts are to be proportioned not only to resist the direct thrust caused by the wind pressure, but also the bending caused by the stresses in the knee bracing, according to the method given in Burr's work on "Stresses in Bridge and Roof Trusses."

Portal and lateral struts subjected to bending must first be proportioned for direct stresses due to both wind pressure and the initial tensions on the rods meeting at one end of the strut, and then to their sections must be added sufficient area to resist the bending.

Bending Effects on Posts and Batter Braces.

But the bending effect in the posts and batter braces caused by the stresses in the intermediate struts or knee braces not be considered to occur, when the bridge is fully loaded; so unless the dead load stresses and the bending together call for more section than the dead and live loads combined, the bending in these members may be neglected.

Initial Tension.

To allow for the stresses caused in adjustable members, the stress in each member is to be increased by the amount given in the following table:

1" ⊙	1.00 tons.	1¾" ⊙	2.50 tons.
1⅛" ⊙	1.25 "	1⅞" ⊙	2.75 "
1¼" ⊙	1.50 "	2" ⊙	3.00 "
1⅜" ⊙	1.75 "	2⅛" ⊙	3.25 "
1½" ⊙	2.00 "	2¼" ⊙	3.50 "
1⅝" ⊙	2.25 "	2⅜" ⊙	3.75 "
2⅛" ⊙	4.00 tons.		

Square or flat bars are to receive the allowance for equivalent rounds rods.

Connection for Lateral Systems.

Whenever it be possible, the lateral rods of both upper and lower systems are to be connected directly to the chord pins. But, if the rods exceed one and three-quarter ($1\frac{3}{4}$) inches in diameter, bent eyes are not to be employed.

Lower lateral rods are to be attached to the floor beams unless the latter be riveted to the posts; *i. e.*, with suspended floor beams, lower lateral struts, attached either to the chord pins or to the posts where the pins pass through, and passing between the track stringers and the rails, or through the webs of the track stringers, must be employed. If wooden track stringers alone be used, they must rest upon the lower lateral struts, which must be of hard wood, and rest in their turn upon the floor beams to which they are to be well bolted. The lateral rods will pass under, through or

* From other selected papers of the Rensselaer Society of Engineers.

over the stringers, according to whether the latter rest upon the lateral struts or the floor beams, or be attached to the webs of the floor beams. When they pass over the stringers, the latter are to be provided with hard wood shims bolted thereto, through holes in which pass the rods and upon which rest the sleepers.

Should the sizes of the lateral rods be such as to prevent the use of bent eyes, pins passing vertically through the ends of the lower lateral struts or through the wrought-iron jaws, if the struts be of wood, are to be employed.

Stresses in End Lower Lateral Struts.

In figuring the stress in a lower lateral strut at the roller end of a bridge, the stress caused by the wind pressure is to be added to the transverse component of the initial tension in the end lateral rod, and from the sum is to be substracted the product of the pressure on the windward shoe, when the bridge is subjected to the greatest wind pressure, by the co-efficient of friction of iron upon iron, which is about 0.25 for this case.

Stiffened End Panels.

In spans less than one hundred and thirty (130) feet long the lower chord bars of the two panels nearest each end of the bridge must be made to resist both tension and compression, as must also any lower chord bar, in which the compressive effect of the wind, when the bridge is empty, exceeds the tension due to the dead load. Where two channels are employed for the lower chord section, the effective area of the webs alone must be counted upon to resist tension.

Top Chord and Batter Brace Sections.

The top chord and batter brace sections, whenever large enough channel bars are procurable, shall consist of two channels with a plate above and latticing below, the lattice bars being riveted together where they cross each other. Broad lacing with two rivets at each end may be substituted for the latticing.

The top plates must be of the same section throughout, the increase in sectional area of the chords from the ends to the middle being obtained by thickening the webs of the channels. When sufficiently large channels are not procurable, the upper chords are to be built of plates and angles, care being taken to remove the material as far as possible from the neutral surfaces.

Post Sections.

Posts are to consist of two channels with lattice bars riveted together at their intersections, or with broad double riveted lacing bars. The upper ends of the posts may be either rigidly attached to the upper chords by plates, or may be hinged on the upper chord pins. When sufficiently large channels are not procurable, plates and angles may be used with the same restrictions in regard to a favorable disposition of material as mentioned in the case of the upper chord sections.

Upper Lateral Strut Sections.

Upper lateral strut sections are to be formed of two channel bars laced or latticed and rigidly attached at their ends to the chords.

Sections of Bars.

Whenever practicable, the ratio of width to depth of bars is to be made as nearly as possible equal to one to four (1:4).

Working Tensile Stresses.

The intensities of working stresses for iron in tension in the various members are as follows:

Lower chord bars, five (5) tons; middle panel diagonals, counters and hip verticals, four (4) tons; flanges of rolled beams, five (5) tons; flanges of built beams (net section), four (4) tons; lateral and vibration rods, seven and a half (7½) tons; beam hangers, two (2) tons; end main diagonals, five (5) tons, and intermediate main, diagonals, between four (4) and five (5) tons, according to the position, the amounts being determined as follows: Let n = the number of panels between that containing the end main diagonal and that containing the first adjustable parallel diagonal. Also let m be the number of the diagonal, the intensity of working stress for which is required, starting at the end main diagonal and counting toward the centre of the bridge, then the intensity of working stress required will be $5 - \frac{m-1}{n+1}$ tons. The ton referred to in these specifications is equal to two (2000) thousand pounds.

Working Compressive Stresses.

For struts composed of two channels with plates, lacing or latticing, or struts built of plates and angles in shapes resembling that of the channel strut, the following formulæ are to be used in finding the intensities of working compressive stresses. First, for lateral and intermediate struts:

$$p = \frac{f}{p + \frac{H^2}{C}}$$

$$3 + \frac{H}{30}$$

And second for all other struts:

$$p = \frac{f}{1 + \frac{H^2}{4 + \frac{H}{20}}}$$

Where p is the intensity of working stress, and H = $\frac{\text{length of strut.}}{\text{diameter of strut.}}$

$f = \begin{cases} 38{,}500 \text{ for two fixed ends.} \\ 38{,}500 \text{ for one fixed end and one hinged end.} \\ 37{,}800 \text{ for two hinged ends.} \end{cases}$

And

$C = \begin{cases} 5{,}820 \text{ for two fixed ends.} \\ 3{,}000 \text{ for one fixed end and one hinged end.} \\ 1{,}900 \text{ for two hinged ends.} \end{cases}$

Where I beams are employed for intermediate lateral struts or end lower lateral struts, the intensities of working stress are to be found by dividing the ultimate resistances, as given by the maker, by the product of the area of the section and the expression $\left(3 + \frac{H}{30}\right)$, H having the same value as in the previous formulæ. For the flanges of rolled beams the intensity of working compressive stress is to be taken equal to five (5) tons, and for the flanges of built beams four (4) tons on the gross section.

Working Shearing and Bending Stresses.

The intensity of working shearing stress for rivets is to be taken equal to three and three-quarters (3¾) tons for members belonging wholly to the lateral systems and sway bracing, and three (3) tons for all other rivets.

The intensity of working bending stress for rivets and pins belonging wholly to the lateral systems or sway bracing, is to be taken equal to eleven and a quarter (11¼) tons, and for all other rivets and pins seven and a half (7½) tons.

Where steels pins are employed, the intensity of working bending stress must not be taken greater than twelve (12) tons, unless special experiments on the steel used show a greater ultimate resistance than sixty (60) tons per square inch, in which case a factor of safety of five (5) may be used.

Size of Upper Lateral Rods.

In many cases the stresses in the upper lateral systems in through bridges, or the lower lateral systems in deck bridges, call for sections of rods which would be practically too small. The inferior limits for the diameters of the end rods in such cases are to be taken from the following table, and the sizes are to diminish gradually to the centre of the bridge:

Diameter of Rod.	Length of Span.	
	From	To
1 "		80'
1⅛"	80'	100'
1¼"	100'	140'
1⅜"	140'	170'
1½"	170'	200'

Stiffened Hip Verticals in Pony Trusses.

Hip verticals in pony trusses are to be stiffened so as to resist compression.

Upset Rods.

Middle panel diagonals, counters, lateral rods, vibration rods and all other adjustable rods are to have their ends enlarged for the screw threads, according to the table given on pages 126 and 127 of "Carnegie's Pocket Companion."

Trussing.

Trussing for compression members is never to be employed on a railroad bridge.

Minimum Dimensions of Chord and Batter Brace Plates.

The minimum dimensions for the top plates in top chords or batter braces are to be taken from the following table. Should the width employed exceed that given in the table by from forty (40) to sixty (60) per cent., the thickness must be increased by one sixteenth (1/16) of an inch; if it exceed from sixty (60) to eighty (80) per cent., the thickness must be increased by one eighth (⅛) of an inch:

Depth of Chord.	Minimum Thickness.	Minimum Width.
6"	¼"	8 "
7"	¼"	9 "
8"	⅜"	10 "
9"	⅜"	11½"
10"	⅜"	12½"
12"	⅜"	15 "
15"	⅜"	18½"
18"	⅜"	22½"
20"	⅜"	24½"
22"	⅜"	27 "
24"	⅜"	29 "

Sizes of Stay Plates.

The dimensions of stay plates in struts where latticing or double riveted lacing is employed, are not to be less than those given in the following table. If the distance between the inner faces of the channels (channels may be either rolled or built of plates and angle irons) be more than the depth of the channels and less than one and a quarter (1¼) times the same, either the thickness of the stay plates must be increased one-sixteenth (1/16) of an inch above that given in the table, or the width must be increased sufficiently to allow space for one more rivet on a side; or, if the distance between the faces be between one and a quarter (1¼) and one and a half (1½) times the depth of the channels, both of these changes in width and thickness must be made; while, if the distance between the faces be more than one and a half (1½) times the depth of the channels either the thickness must be increased by one-sixteenth (1/16) of an inch and the width sufficiently for two more rivets on a side, or the thickness must be increased one-eighth (⅛) of an inch, and the width sufficiently for one more rivet on a side:

Depth of Channels.	Thickness of Stay Plate.	Width of Stay Plates.	No. of Rivets on a Side.
5"	5/16"	4 "	2
6"	¼"	4 "	2
7"	¼"	4 "	2
8"	⅜"	4 "	3
9"	⅜"	6½"	3
10"	⅜"	6½"	3
12"	⅜"	6½"	3
15"	⅜"	7½"	3
18"	⅜"	7½"	3
20"	⅜"	8½"	3
22"	⅜"	8½"	3
24"	⅜"	8½"	3

But if the single riveted lacing be used, the dimensions of the stay plates are to be taken from the next table, the same allowance as before being made for increased distances between channels:

Depth of Channels.	Thickness of Stay Plate.	Width of Stay Plate.	No. of Rivets on a side.
5"	¼"	4"	2
6"	¼"	6½"	3
7"	¼"	6½"	3
8"	⅜"	6½"	3
9"	⅜"	8½"	4
10"	⅜"	8½"	4
12"	⅜"	8½"	4
15"	⅜"	9½"	4
18"	⅜"	9½"	4
20"	⅜"	10½"	4
22"	⅜"	10½"	4
24"	⅜"	10½"	4

(TO BE CONTINUED.)

THE following is an abstract of the proposals received by Colonel Gillmore for improving harbor at Charleston, Ga.:

P. Sanford Ross, $232,950.
Rittenhouse Moore, $308,250.
J. F. Gaynor, $239,900.
Wm. H. Brown, $286,608.
Alfred Ames Howlett, $230,509.

The contract has been awarded to Mr. Howlett.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER, M.Am.Soc.C.E.: M.Inst.C.E.

TERMS OF SUBSCRIPTION:

$4.00.....PER YEAR TO U. S. AND CANADA.
$5.00..... " " " FOREIGN COUNTRIES.

TABLE OF CONTENTS.

	PAGE
Six-pounder Rapid-Firing Gun for the British Navy (*Illustrated*)	121, 122, 123
General Specifications for Ordinary Railroad Bridges	124, 124
Sanitary Condition of the City of Mexico	126
The Tehuantepec Ship Railway	126
South American Railroads	126, 127
Distribution and Dual Supply of Water	127, 128, 129
The Crown Gas Pumping Engine (*Illustrated*)	129
Award of the Institution of Civil Engineers	130
Army and Navy Notes	130
History and Statistics of American Water-works	130
Water	131
News of Week	131, 132
Competition	132

Make all drafts, cheques and money orders payable to **Engineering News Publishing Co.**

THE detailed route of the New Croton Aqueduct is given most minutely in the New York *Times* in the shape of a four-column advertisement for appraisal purposes.

THIS has been the hottest week of the season. The suffering in this and other large cities of the Union has been very great. For an entire week the mercury ranged from 92° to 96°, until on Thursday night relief came. There were numerous cases of death and prostration from the heat reported; the full effects of it throughout the City cannot easily be estimated.

The mortality among horses was very great; notwithstanding the extra precaution taken by the car companies nearly fifty of their horses succumbed to the heat. The employees on the Elevated roads suffered greatly also and it was dangerous to work on the track in the middle of the day. Crossing on the footway of the Brooklyn Bridge was a perilous undertaking.

Sanitary Condition of the City of Mexico.

By situation the City of Mexico should be one of the most healthful cities of the continent, but the lack of a pure water supply and of any adequate system of sewerage puts it at the bottom of the list in any classification on the principle of healthfulness. According to Mr. C. H. N. Blake, C. E., the comparative death rate in some of the larger American cities is the following:

New York, population in 1880, 1,206,299; death rate 1883, 22 per 1,000; average duration of life, 45.5 years.

Brooklyn, estimated population in 1883, 644,526; annual death rate, 19 per 1,000; average duration of life, 52.6 years.

San Francisco, population in 1880, 233,959: death rate 1883, 20 per 1,000; average duration of life, 50 years.

Boston, population in 1880, 362,839; average death rate, 22 per 1,000; average duration of life, 45.5 years.

Mexico, estimated population 300,000; average death rate, 50 per 1,000; average duration of life 20 years.

If the native sentiment in Mexico was less hostile to enterprises by foreign capital, we should say that there was a first-class opening for some of our moneyed corporations to step in and gaurantee the rising generation in Mexico's capital city, an average life of more than twenty years, by means of a proper system of sewerage and water supply. Under the present condition of affairs, however, the question as to whether the profits would balance the risks in this or any similar Mexican enterprise is one that will bear close study and investigation.

The Tehuantepec Ship Railway.

The following facts in regard to the present condition of this enterprise are gathered from the London (Eng.) *Times*.

The entire route has been surveyed and all difficult parts of the Isthmus have been covered with full and accurate topographical maps. The construction has been carried forward on the Atlantic division, and a careful and extended examination and study made of the harbors.

Based on these surveys the plans for the construction have been worked out in detail, both for the roadbed and its superstructure, and for the harbor improvements.

The various problems of mechanical construction arising from the attempt at lifting and transporting such immense masses, have been carefully studied out.

The result of these studies have been embodied in a working model—combining the lifting-dock,—pontoon-carriage and a steamer—the whole model occupying thirty feet in length.

Without giving a detailed description of the proposed plans, it should be stated that the earlier plans have been greatly modified. Instead of being drawn up an incline, the vessels are to be raised by a vertical lift on a floating pontoon, a system of hydraulic rams taking the weight of the vessel under the keel and bilges, and supporting it in a natural and unstrained position, so that the vessel is virtually water-borne through the lifting, transporting and lowering process.

Three tracks, each of the standard gauge of four feet and one half inches, will be laid on a solid roadbed, constructed of excellent materials in the most thorough manner.

The carriage that carries the vessel is most ingeniously constructed. The immense weight of the maximum load is so evenly distributed as not to bring upon any one wheel a strain of eight tons, which is less than that borne by wheels on ordinary railroads. Any irregularities in the track will be overcome by powerful springs placed over each pair of wheels and allowing a movement of five inches.

South American Railroads.

Abstracts from the annual report of the Andian Railroad of the Argentine Republic for the year 1883.

Gross Earnings	$417,662.46
Expenses	229,489.13
Net Earnings	188,173.33

During the year the line was extended from 350 kilometers in length to 470 thus taking an average of 400 kilometers we have:

Gross earnings per kilometer	$1044.15
Expenses " "	573.72
Net Earnings " "	470.43

Expenses $54\frac{94}{100}$ % of gross earnings.

Net earnings per kilometer the eight preceding years.

'76	'77	'78	'79	'80	'81	'82	'83
$ 59.22	$ 75.52	$ 87.18	$115.87	$280.58	$154.02	$385.36	$470.43

During the first four years the road was operated by a corporation; result $327.79 per kilometer government review; during the last four years operated by the government direct, result $1290.39 per kilometer.

DISTRIBUTION OF RECEIPTS.

Freight	$318,790.74
Passenger	81,606.90
Government service	8,345.77
Excess Baggage	6,273.31
Telegraph	791.30
Supplies	614.10
Special trains	231.00
Rents	660.00
Various	394.34
	$417,662.46

$76\frac{32}{100}$ per cent. Freight.
$19\frac{53}{100}$ per cent. Passenger.
$4\frac{15}{100}$ various other.
Receipts are also divided into two classes.

$358,034.05	Commercial service.
59,628.41	Co. materials for construction.
$417,662.46	

DISTRIBUTION PER MONTH.

January	$23,308.66
February	25,210.06
March	29,785.12
April	30,863.85
May	29,533.14
June	31,474.56
July	33,312.48
August	34,418.90
September	37,095.11
October	53,092.34
November	43,778.91
December	45,789.03
	$417,662.41

The increase in the receipts for the months of October, November and December is partially due to the opening (Sept. 1st) of the line from San Luis to La Paz.

DISTRIBUTION OF EXPENSE ACCOUNT.

Maintenance and Betterment	$46,131.90
Motive Power	74,791.11
Shops	10,771.79
Rolling stock	16,380.80
Transportation	62,812.36
Management	18,601.17
	$229,489.13

DISTRIBUTION OF TRAFFIC RECEIPTS.—NUMBER OF PASSENGERS.

First-class	10,277	
Second-class	13,719	
Total	23,996	
Freight, in kilograms		83,355,822
Government goods		138,056
Excess baggage		182,131
		83,676,009

EQUIPMENT.

Locomotives	10	
Passenger and baggage cars	30	
Freight cars (all classes)	254	
Average service of locomotives	22,406	kilos.

Classification of freight, in kilograms = 1000 kilos = 1 gross ton.

Wines	3,220,940
Liquors	675,160
Hardware (heavy)	4,236,600
" (shelf)	3,581,940
General merchandise	7,042,825
Drugs	132,990
Fruits	342,930
Explosives	692,050
Hides	1,929,894
Wool and hair	1,254,840
Bones	317,000
Ore and metals	98,270
Flour	5,116,720
Wheat	766,210
Corn	1,827,762
Mill feed	164,090
Lime and Roman earth (cement)	1,956,500
Lumber	4,919,660
Wood and Charcoal	11,983,171
Straw, cane, bricks, stone and sand	625,730
Household goods	938,830
Plants	908,850
Machinery	129,808
Sugar	2,400,350
Salt	230,980
Tobacco	289,400
Empty packages	1,197,381
Animals on foot	166,840
Miscellaneous	839,450
Beer	212,520
Refuse	49,039
Seeds	296,790
Flagging	170,800
Paper	41,461
Construction material	25,295,221
	83,355,823

Construction account on the two branches as follows:

Section from Mercedes to San Luis,	1,093,047.38
Section from San Luis to La Poz Mendoza and San Juan	1,797,107.36
Total.....	$2,890,154.74

[This abstract will give the reader a fair idea of the railroad business in the interior of Argentina as this road does not touch the coast, and is wholly dependent upon the country through which it runs for its business, excepting so far as imports which it receives from the Argentine Central, running to Rosario on the coast, or more properly on the La Plata River.

The expenses of the motive power department are large on account of supplying skilled and mostly foreign labor; also the cost of fuel.

A study of the classification will give a fair idea of the products and imports of the country, and their respective quantities, while the construction account shows no little enterprise.]

Awards of the Institution of Civil Engineers.

THE Council of this Society has made the following awards to the authors of some of the papers read and discussed at the ordinary meetings during the past session, as set against their respective names:

A Watt Medal and a Telford Premium to Sydney Walker Barnaby, for "Hydraulic Propulsion."

Telford Medals and Telford Premiums to Samuel Bagster Boulton, "The Antiseptic Treatment of Timber;" and to William Foster, "Experiments on the Composition and Destructive Distillation of Coal."

Also T. Ilford premium to William Tregarthen Douglas, "The New Eddystone Lighthouse;" to James Atkinson Longridge,† "Wire-Gun Construction;" and to William Hackney,‡ "The Adoption of Standard Forms of Test Pieces for Bars and Plates."

The Manby Premium has been bestowed upon George Henry Stayton, for "Wood Pavement in the Metropolis."

For papers printed in the proceedings without being discussed:

Telford Medals and Premiums have been awarded to Thomas Andrews, for "Galvanic Action between Wrought Iron, Cast Metals, and various Steels, during Long Exposure in Sea-Water," and to Francis Collingwood, "On Repairing the Cables of the Allegheny Suspension Bridge at Pittsburg, Pa., U. S. A." While Telford Premiums have been given to James Henry Apjohn, "The Area of Sluice-opening necessary for the Supply Sluice of a Tidal Canal;" to Thomas Gillot "On the Basic, Open Hearth Steel Process;" to James William Wyatt, "On the Art of Paper Making by the Machine, as exemplified in the Manufacture of High Class Writings and Printings;" and to William Santo Crimp on "The Wandel Valley Main Drainage."

In addition to the ordinary meetings, there are supplemental meetings for the reading and discussion of papers exclusively by students of the Institution. Some of these communications have been awarded as follows:

The Miller scholarships of 40*l.* annually for three years to Alfred Richard Sennet, for his paper "On the Electric Light."

And Miller Prizes to Peter Chalmers Cowan, "The New York, West Shore, and Buffalo Railway, and the Methods used in its Construction;" to Walter Osmond Rooper, "Emery Wheels and Emery Wheel Machinery"; to Richard Moreland (*tertius*), Constructional Ironwork for Buildings;" and to Edward Woodrowe Cowan and James Fawcus, "A Light Draught Launch."

ENGINEERING NEWS: Three months for One Dollar.

† Has previously received a Telford Medal and also a Watt Medal.

‡ Has previously received a Telford Medal.

Distribution and Dual Supply of Water.*

BY HENRY J. MARTEN, M. INST., C. E.

Until comparatively recent times no attempts were made to afford what we now term a "domestic supply," that is to say, a supply of water distributed to and available within each house for general domestic purposes.

The large supplies of fine water introduced into the principal cities of ancient times, by means of the magnificient aqueducts of which there are many remains to this day, were directed, so far as distribution is concerned, to the supply of public baths and fountains, and possibly here and there to the supply, for similar purposes, of a few of the private residences of the wealthy classes.

A house to house supply, such as we have in modern times, was unknown and undreamt of. The supply for domestic purposes had to be obtained by the occupants of the houses either from the public fountains or from the streams flowing from them, or was supplied in detail by water carriers, somewhat after the fashion in which milk is now supplied from house to house. Although according to Pliny, the ancients were aware that water under pressure rises to the height of its source, little practical advantage was taken of the knowledge of this fact. Water under pressure was occasionally conveyed for some distance through stone or earthenware tubes or in leaden pipes. The two former were, however, difficult to be kept tight, and the latter were not only very expensive, but, at an early period of their history were found to act deleteriously on the water flowing through them. Although, therefore, immense volumes of water were frequently brought into ancient cities, as into Rome, where, according to Strabo, "whole rivers flowed through the streets," and where the total quantity so delivered probably exceeded three hundred gallons per diem to each inhabitant, there was practically no distributed domestic supply.

The inhabitants of modern London, therefore, although only furnished with a supply per head equal to one-tenth of that which used to flow into old Rome, are, nevertheless, infinitely better off than the ancient Roman, because the thirty gallons supplied to the modern Londoner are delivered exactly where he requires it, "upstairs, downstairs, or in my lady's chamber," and the supply is at all times available by the mere turning of a tap. We have here a good illustration showing how various combinations of applied science, united to the practical skill of modern times, have resulted in a tenfold economy, coupled, at a moderate estimate, with a tenfold advantage to the water consumer.

If modern London were supplied in the same wasteful and unscientific manner as ancient Rome, the quantity of water required for the purpose would exceed in volume the average flow of the River Thames at Kingston, and whilst this immense volume of water would be rushing from public fountains, and down open channels made for the purpose in the streets, the inhabitants would be totally without the comfort and advantage which they at present enjoy of a domestic supply delivered under pressure into each of their houses.

Coming to modern times, the distribution of a domestic supply dates back from the time of Peter Morice, who, in 1582, erected waterworks for the supply of the City of London by means of pumps actuated by water-wheels placed in the first two arches of old London Bridge. He appears to have distributed the water under pressure through leaden pipes, but it is probable that a few years later these were replaced by wooden pipes, which, as early as the year 1628, were being laid down by the New River Water Company. These wooden pipes consisted of the trunks of elm trees, cut into lengths and bored longitudinally to an internal diameter of from 6 to 12 inches, in accordance with the internal pressure they were required to withstand. In the parts of the town lying at the lower level (where the pressure would be greatest), the diameter of the bore would be 6 in., so as to leave a considerable thickness of wood between the inside of the bore and the outside of the tree. In the higher parts of the town, and near the reservoirs, where the pressure would be less, the bore would be gradually increased to 12 in. in diameter, a less thickness of timber being required in those parts. The joints of these wooden pipes were made by forming one end of the tree into a conical shape, and hollowing out the other to correspond; the several lengths, when laid, being driven one into the other.

These wooden pipes, however, proved very defective, as the loss by leakage was estimated at not less than one-fourth of the whole quantity flowing through them. From decay and other causes they required also to be renewed on an average about once in every twenty years; and consequently, as at one time the New River company had 400 miles of these pipes laid down, they had to take up, and renew upwards of twenty miles in length each year.

Owing also to the small diameter of these wooden pipes, where they had to bear any amount of pressure, more than one line—and in one case no less than nine lines—of pipes had to be laid side by side in the same street, in order to furnish the requisite supply.

When we reflect on the fact that at this period London was almost entirely without under drains, we may be able to form some slight idea of the terrible amount of moisture with which the foundations and basements of the houses adjoining these lines of leaky pipes must at all times have been saturated, and the disturbance which the constant repair and renewal of these pipes must have occasioned to the roads.

Bad, therefore, as matters are at the present time in London and other large towns, from the disturbance of the streets for such repairs, we of the present generation may congratulate ourselves upon the fact that, notwithstanding we now have gas-pipes, sewers, and underground electric wires in addition to water-pipes laid under the street, the annoyance which we suffer from streets disturbance is as nothing compared with that which our ancestors must have had to put up with in this respect.

There are no records to which the writer has access showing whether, in these early times, the supply for domestic purposes was on the constant or intermittent system, nor whether ther water was delivered at the ground floor of each house only or at a higher elevation. With wooden distribution pipes, such as these described, it would be very difficult to have a proper service of stop or shut-off valves, even if an efficient stop-valve for working under pressure were then invented. The frequent stoppages for repairs would necessarily assimilate the arrangements for supply to those of the intermittent system, which involves the necessity of having tanks, butts, or other capacious receptacles for the storage of water in each house.

In the early part of the present century, cast-iron mains began to be substituted for wooden water-pipes, and by the year 1820 the whole of the wooden pipes belonging to the New River Company had been removed and replaced by cast-iron ones. The substitution of cast iron for wood introduced a new era into the art of water distribution, as much higher pressures were rendered available, and leakage was materially reduced. The early cast-iron pipes, although made of the finest cold blast metal, were very rough productions.

*From a paper read at the Society of Arts.

They were all cast horizontally, and in numerous cases, owing to the imperfection of the machinery, they were far from being either cylindrical or concentric, and thus were frequently thicker on one side than the other. They often, therefore, gave way when exposed to the working pressures they were called upon to sustain, the methods of testing them, previous to their being laid, being primitive and inefficient.

The first cast-iron distribution pipes were made with flanges, on the same principle as the ordinary cast-iron pump trees. These flanges were fastened together with bolts and nuts, the joint being made between the flanges, with an iron ring covered with tarred yarn or flannel. This method, however, soon had to be abandoned, as owing to the expansion and contraction of the pipes consequent on the changes of temperature in the water passing through them, the flanges were frequently torn off, and hence stoppages for repairs were numerous.

This defect was overcome by the introduction of the spigot and socket pipe. The early joints of these pipes were made by driving soft wood wedges into the sockets, which were made wide for the purpose. When the wedges had been driven into the sockets as far as was considered prudent, the ends projecting beyond the sockets were cut off, and a few small iron wedges were then driven into the wood for the purpose of giving a final tightening. These joints were found to be a great improvement on the previous system of flanges; but as the wooden wedge became saturated with water, they expanded, and frequently burst the sockets. This led to the abandonment of the system of joining pipes with wooden wedges, and to the adoption of the plan of filling the back part of the socket with yarn tightly rammed in, and then running the remainder of the socket full of molten lead, which on cooling was caulked up, and so made a tight and permanent joint, capable of withstanding the full pressure to which the pipe might be subject, and, at the same time, of allowing for expansion and contraction without leakage.

This method, for the first time, gave those responsible for the distribution of water under pressure the advantage of having at command continuous distributing tubes of any length, and practically water-tight under any ordinary pressures.

The lead joint, as above described, with variations only for reducing the weight of lead used, or for adding to its security against being blown out by back pressure, has remained a permanent institution, a bar of lead being occasionally substituted for the molten metal.

In some cases, the old-fashioned method of joining the wooden pipes has been imitated in their cast-iron successors, by turning the conical end to the spigot, and boring the socket, so that, when fitted together, the pipes practically joint themselves without any other stopping.

With the introduction of cast-iron pipes, and greater pressure, the system of intermittent supply became more completely developed and established.

Under the intermittent system, the supply of water was not constantly laid on, as is now almost universally the case. The arrangement was to turn on the water from the principal main into the subsidiary distribution pipe, in any particular street, for an hour or an hour and a-half a day; during which time all the people in that street had to draw and store a sufficient supply for the remainder of the twenty-four hours.

This system, with which the public were long content, ultimately fell into disfavor. Its inconveniences were great; the water was, as stated, only turned on for a very short time; the system necessitated the employment of a large number of turncocks, whose sole business it was to go round the districts to turn the water on and off. The intermittent system was also injurious on sanitary grounds, as it frequently happened that the vessels in which the water was stored were exceedingly foul, in consequence of putrifying sediment left in them from previous supplies, and the stored water itself was apt to become impregnated with poisonous gases rising through the waste or overflow pipes of the cisterns which were connected with the sewers.

The sanitary defects thus inherent in the intermittent system were the fruitful source of disease and death, and early engaged the attention of the Board of Health presided over by the late Earl of Carlisle, and of which Mr. Edwin Chadwick, C. B., was the earnest and indefatigable secretary. After much inquiry the Board came to the conclusion that these evils could be remedied by the adoption of the constant supply system, which had been introduced at Nottingham by Mr. Thomas Hawksley, past president of the Institution of Civil Engineers, and was in successful operation there on a large scale.

Under the "constant" system, the supply is kept on the whole 24 hours, so that anyone, at any time of the day or night, by simply turning a tap in the house, can obtain a supply direct from the main without the intervention of any intermediate storage vessel.

When the proposition for affording a supply on the constant system was first broached by the Board of Health, it was met by a storm of opposition, some engineering advocates of the old system going so far as to allege that it would be a sheer impossibility to carry out the constant system, on account of the uncontrollable waste that would result from having the water always "on," and because, as there was no guarantee that everybody would not be drawing water at the same time, the main pipes would in consequence have to be of enormous magnitude compared with those necessary under the intermittent system, under which system it was alleged the supply could be more judiciously and economically manipulated.

The controversy on this question raged with great vigor from 1845 to 1850. About that time Sir Robert Rawlinson, C. B., having occasion to visit Wolverhampton in connection with a local inquiry under the Board of Health, asked the writer, who had then recently converted the supply of that town from the intermittent to the constant system, and who at the moment had the means of doing so with great accuracy, to institute some experiments with a view to ascertain what, under the constant system, was the actual rate of consumption each hour of the day. As the result of these experiments, the writer found that, so far from all the people drawing from the mains at the same time, the highest rate of consumption was only about two and a half times the total daily supply; that is to say, that the main and distribution pipes under the constant system should be of a capacity sufficient to supply two and a half times the ordinary daily consumption. Now, as under the intermittent system it was the practice to make the mains and distribution pipes of sufficient capacity to supply four times the ordinary daily consumption, these experiments proved that, so far from larger mains being required under the constant system, they might actually be made of smaller capacity than those required for the intermittent system. It was also shown that, with proper fittings in the houses, the consumption of water under the constant supply system was actually less than that under the intermittent system.

These facts being reported by the Board of Health, and afterwards given in evidence by the writer before a committee presided over by the late Sir James Graham, and confirmed also by similar results in other cases, brought the controversy to a close in favor of the constant supply system, which is now almost universally adopted, and under which 263,904 out of the 671,888 houses in the London district are now supplied, as stated in the able and and interesting report for May, 1884, of Colonel Francis Bolton, C. E., Official Water Examiner under the Metropolis Water Act, 1871.

The introduction of the system of constant supply brought about other advantageous changes in the method of distribution. Under the intermittent system the water lay stagnant in the distribution pipes for at least twenty-two out of the twenty-four hours each day, and before the introduction of filter beds these pipes were practically small settling reservoirs, in which the sediment accumulated, and which sediment, when the water was turned on, was driven with the first rush, in a semi-putrescent state, into the household storage receptacles.

Under the intermittent system, but little attention was paid to the fittings in the houses, as neither those supplying the water nor those receiving it troubled themselves much about waste, which in each case did not last more than an hour or an hour and a-half each day. Hence taps, ball-cocks, house supply pipes, and other internal fittings were old-fashioned and defective almost beyond description.

With the advent of the constant system, new descriptions of fittings were introduced to prevent waste, and to meet the requirements of the greater pressures at which the water then began to be delivered.

It may be safely affirmed that the constant system has brought about an extraordinary change for the better in all domestic water fittings; those now in general use displaying an amount of skill, ingenuity, and good workmanship far superior to anything ever before known.

Under the intermittent system the distribution pipe generally laid a "dead end" in each street, because the water requiring to be daily turned on or shut off, the pipe could only be connected at one end with the feeding main, leaving the other end isolated or "dead."

The water near these dead ends became very foul from stagnation, and consequently the dead end required frequently to be washed out. This was effected by drawing a wooden plug fixed in a branch at the end of the distributing main. When this plug was drawn, it was not at all uncommon to see the water spouting out from it tinted with all the colors of the rainbow, from dark purple to the brighter tints, and emitting a most offensive odor, for when the water was shut off, it frequently happened that the distributing pipe was drained by a discharge at some low lying part of it, and then became filled with an atmosphere drawn through ground full of gas reek.

Under the constant system these evils, including those resulting from dead ends, are done away with; the distributing pipes being now constantly under pressure, no gas reek or other impurities can enter them, and being connected at each end of the street with the adjoining mains, there is a constant circulation throughout the whole system, whereby stagnation is prevented, as the water is always on the move towards the point of greatest consumption.

Very great improvements have also been made under the constant system, in the construction of the sluice-valves for shutting off the water for repairs at any particular point.

Under the intermittent system, the sluice valves were only made to shut against the pressure from one side, whilst they are now universally made to shut against the pressure coming from either side in any direction. These valves, which are called "double-faced," are the invention of Mr. James Nasmyth, so well known in connection with the steam hammer. The writer, then an articled pupil to the

late Mr. Wicksteed, engineer to the East London Water Works, had the privilege of assisting Mr. Nasmyth in preparing the first rough drawing of these "double-faced sluice valves; and he well remembers the instantaneous rapidity with which that great mechanician not only grasped the point to be attained, but within an hour had so completely solved the difficulty to be overcome, that whilst alterations have been made in minor details, no practical improvement has been effected in that first design of his.

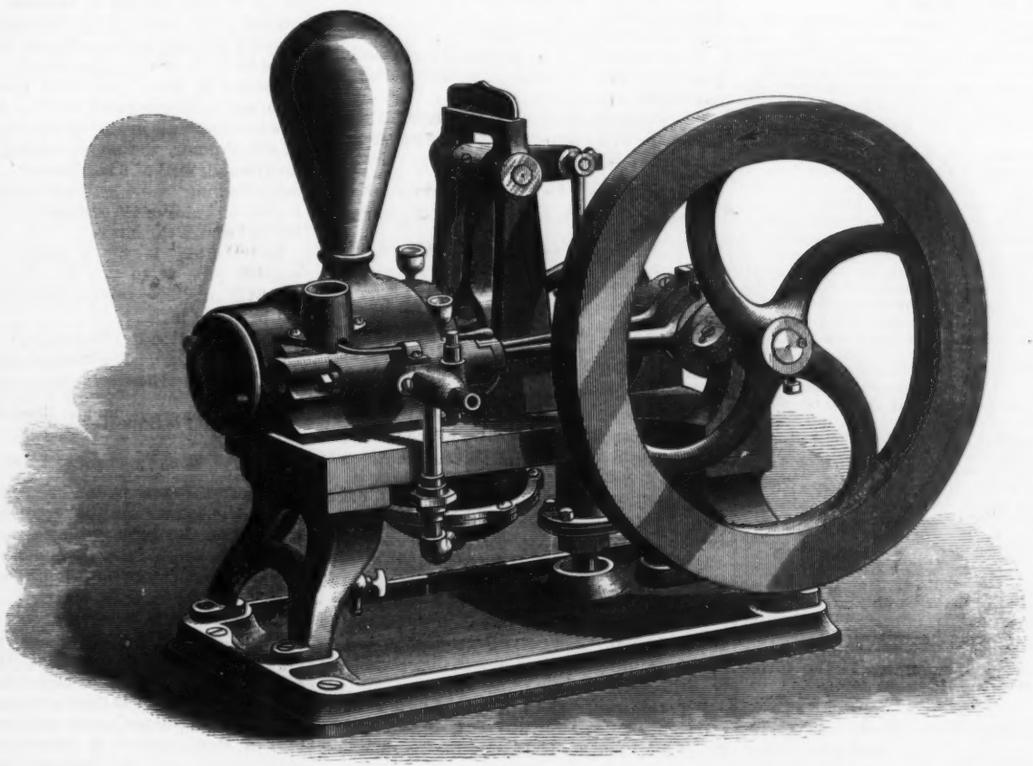
The method of connecting the house services with the main pipes has also undergone a great improvement. In early times the connection was made by driving a brass ferrule into a hole chipped or drilled through the main pipe. These ferrules were apt to be dislodged, and frequently blew out, and the fixing of them obliged the water to be shut off from the whole street during this occasionally tedious operation. These connections are now made by screw threaded ferrules, tapped securely into the pipe by an instrument which obviates the necessity for any stoppage of the supply to other houses whilst the operation is being performed.

The arrangements also for the supply of water for fire extinction have been very greatly improved since the introduction of the constant supply system. In former times, in the event of a fire, the first thing was to find the turncock to turn the water into the main. This done, the old wooden plug had to be knocked out, often a work of time and difficulty; and then until all the empty tubs and tanks were filled up in the street there was practically very little pressure at the plug, and the supply was consequently scanty for some time. Thus most precious moments were lost. Now, on the contrary, the fireman goes to the nearest hydrant, inserts his standpipe, turns on the water from the constantly charged main pipe, and in a much less time than it previously took to call the turncock, he has a stream of water pouring into or over the burning building at the rate of 200 or 300 gallons a minute, and under a pressure sufficient to knock a strong man down at a distance of fifty yards from the nozzle of the fire hose, and that without the intervention of any fire-engine.

Another little machine which has proved itself to be of great value in connection with constant supply, is the "Waste Water Detector," invented by Mr. Deacon, the engineer to the Liverpool Corporation Waterworks. This machine indicates and registers the flow of water passing through any particular pipe at any moment of time, and by its agency all undue waste and leakage are easily detected and traced. Thus the modern appliances in connection with distribution, if properly used and directed, are now nearly all that can be desired.

Except in very special cases, the writer is not an advocate for the "Dual System," that is a system under which two classes of water are introduced, into a town; the one for dietetic purposes, and the other for washing, street watering, sewer flushing, fire extinguishing purposes, etc. The dual system necessarily involves the laying of a duplicate set of mains, and the fixing of a duplicate set of house fittings, with all the attendant annoyance and expense.

There may be cases where the circumstances are so peculiar as to make the dual system a necessity, and then the difficulty must be faced; but generally it will be found cheaper and better to manipulate the supply so as to make sure that none but water of a high class shall ever enter the mains, and so as to effect the whole work of distribution by one set of pipes and fittings.



THE CROWN GAS PUMPING ENGINE.

The Crown Gas Pumping Engine.

This little motor and pump is the result of an effort on the part of the manufacturers to put a machine upon the market which can safely be left to the care of persons who are not skilled machinists, without suffering too severely from the usage received. With this end in view there has been an attempt to simplify the mechanism as much as possible—doing away with all bevel gearing, etc—to employ large bearing surfaces, and to make all working parts of the best steel, when possible.

The pump cylinder, which is of composition metal, is vertical and the plunger receives its motion from a bell-crank—clearly shown in the cut—actuated by the engine proper. This latter is of the type known as trunk engines, which does away with the cross-head whose guides require constant lubrication and adjustment.

The valves are simple piston valves and are driven by eccentrics on the main shaft, thus avoiding the bevel gearing which is a feature of the valve motion of ordinary gas engines. The outer valve acts as a cut-off, shutting off the supply of gas at a little before half stroke.

At the same moment it starts a jet in a chamber in the inner valve which is lighted from the flame burning continuously in the little chimney, shown in the cut in line with the air chamber. Further travel of the inner valve brings this flame in contact with the mixture of gas and air in the cylinder and at the same time shuts off all communication with external space, and consequently the supply of air. The half cylinder full of gas and air then explodes and drives the piston forward for the remaining half of the stroke. At the commencement of the return stroke, communication with the outer air is renewed, and the products of combustion are forced out, there being hardly any clearance space. The outer valve again permits the flow of gas, the piston pumps gas and air together into the cylinder during the first half of the stroke, and the cycle is complete.

The proper proportion of gas to air is obtained by regulating the supply of gas. The valves are of the best quality of tool steel and after three months' use show no signs of wear.

The size of pump illustrated will force 200 gallons per hour to a height of 50 ft. with a consumption of 8 ft. of gas. This does not show a very high grade of economy, but in small motors the cost of attendance and repairs constitute the principal item of expense, and this the designer of the Crown Gas Engine claims to have reduced to a minimum. The fuel is a very small matter, costing but two cents an hour. For full particulars address the National Water Company, 51 Chambers Street, New York City.

Army and Navy Notes.

The navies of the European Powers may be listed as follows:

England stands first with twenty-five modern line-of-battle ships, fulfilling all requirements of the present time, and fourteen obsolete men of war nine modern and six obsolete ironclads for coast defense and three ironclad cruisers.

France follows with sixteen modern and nine obsolete line-of-battle ships, and seven modern and eight obsolete ironclads for coast defense.

Next to these two most important naval powers ranks Germany, with nine modern (five ironclad frigates, four ironclad corvettes) line-of-battle ships, fulfilling all requirements of the present day, and three obsolete ironclad ships (the ironclad frigates Kronprinz and Friedrich Karl, and the ironclad corvette Hansa,) eleven modern ironclad vessels for coast defense (eleven ironclad gunboats all completed,) and one obsolete vessel, the ironclad Arminius.

Austria takes fourth place, with three modern and seven obsolete line-of-battle ships.

Italy has two modern and eleven obsolete ironclad ships at her disposal.

Russia has only one single first-class line-of-battle ship and seven obsolete ironclads, two modern and sixteen obsolete ironclad vessels for coast defense, and four ironclad cruisers.

Denmark possesses two modern and two obsolete line-of-battle ships, and two modern and two obsolete ironclad vessels for coast defense.

Holland, one modern battle ship and seventeen modern ironclad vessels for coast defense

This shows that Great Britain still holds first place with her ironclad fleet; France, second; Germany, third; Autria fourth; Italy, fifth, and Russia sixth] place. France, however is building at present fourteen vessels of the most powerful description, an , eight similarly powerful ironclad vessels for coast defense against seven line-of-battle ships and five ironclad cruisers building in Great Britain. In a few years, therefore, France will be able to dispose of thirty battle ships, of which twelve are of first-class fighting power, and Great Britain of thirty-two battle ships, numbering however, only a single vessel of about e qual strength to the twelve French ships. Italy is constructing five battle ships of first class power; Russia, three battle ships and three ironclad cruisers; Germany, one ironcla l cruiser and two ironclad gunboats; Austria, one battle ship; Denmark, one ironclad for coast defense. Great Britain's preeminence on the seas is, therefore, most decidedly menace l by France, with the completion of the vessels building by both States. As Great Britain is obliged to employ a great portion of her fleet in the Mediterranean and at many distant stations it may be presumed that from 1887 or 1888 a French fleet of forty-two ironclads would be opposed to an English fleet of, at most, thirty ironclads, including in the latter the vessels in reserved for coast defense.

THE INSTITUTION OF CIVIL ENGINEERS.—During the past session of the Institution there have been elected fifty one members, two hundred and fourteen associate members (of whom seventy three were previously students), and thirteen associates. In the period forty five associate members and one associate have been transferred to the class of members and two associates to the class of associate members, whilst one hundred and seventy one students have been admitted. The register and lists now contain the names of twenty one honorary members, one thousand four hundred and thirty nine members, one thousand eight hundred and sixty four associate members, five hundred and ten associates, and seven hundred and seventy eight students, making a total of four thousand six hundred and twelve of all classes. Ten years ago the gross numbers amounted to two thousand four hundred and sixty eight, and twelve months back to four thousand four hundred, so that the increase in the session had been at the rate of five per cent.

ROWLAND P. HAZARD, Robert W. Blackwell, Josiah L. Blackwell, Philip Cnater, Hugh Stevenson, Everard De Renne, Francis B. Del Calvo, and Warren B. Adriance are the incorporators of the Bentley-Knight Electric Railway Company. The company is to build, sell, and let locomotives and other rolling stock for railways in the United States and Canada. Its capital stock is $1,000,000, divided into shares of $100.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(Continued from page 117.)

DCLXXV. RICH HILL, MO.

Rich Hill, Bates Co., Missouri, in lat. 38° 10′ N., long 94° 20′ W., is in a fertile region of undulating prairie land. Settled in 1880 it was laid out as a city during the same year.

Water-works were built, in 1883, by a private company after plans of F. Wm. Raeder, who also executed the work, the supply being taken from the Marais des Cygnes River and also from a well 25 ft. in diameter sunk to a depth of 44 ft. The water is pumped by two duplex Blake Steam Pumps of 1,000,000 gallons daily capacity each, 2½ miles through a cast-iron force main to the city limits where closed stand pipes, 30 inches in diameter and 40 ft. high are built.

The fire pressure is 82 lbs.

Distribution is by 6½ miles of cast-iron pipe, with fifty fire hydrants, for which the city pays $500 yearly.

The population, in 1880, was 3,600, it is now said to be more than 5,000. No further information can be obtained.

DCLXXVI. SANFORD, FLA.

Sanford, Florida, in lat. 28° 50′ N., long. 81° 15′ W., is on slightly rolling ground on the St. John's river.

Settled in 1871 it was incorporated a city in 1876. Water-works were built in 1883 by a private company after plans of Terrell and Muckle, the supply being taken from Island Lake, which is fed by springs and has an area of about 40 acres. A 6 in. cast-iron pipe conducts the water 2¾ miles to a Worthington Steam pump of 12 in. steam and 7 in. water cylinder, which lifts it 50 ft. to two circular wooden tanks 18 ft. in diameter, and 12 ft. high standing on wooden trestles 40 ft. high. By direct pumping a fire pressure of 110 lbs. is obtained.

Distribution is by 3½ miles of cast-iron pipe of 6 to 3 in. diameter with 5 fire hydrants, and 70 taps.

The population is fluctuating and is estimated at about 1,200. The daily consumption in 1883 was 25,000 gallons. The cost of the works has been $23,000.

The works are owned by the Florida Land and Colonization company. H. S. Sanford is President, and W. Beardsall Superintendent.

DCLXXVII. SAN MARCOS, TEX.

San Marcos, Texas, in lat. 29° 55′ N., long. 97° 50′ W., the county seat of Hays Co., is on the San Marcos River. Settled in 1820, it was incorporated a town in 1876.

Water-works were built by a private company in 1883, after plans of C. M. Holmes, taking the supply from the river.

The water is pumped by two Worthington water-power pumps of 8½ in. cylinder and 10½ in. stroke to a circular reservoir 60 ft. in diameter and 9 ft. deep, with walls of stone, having a capacity of 230,000 gallons, and being 190 ft. above the pumps and 150 ft. above the town.

Distribution is by 3 miles of cast and wrought iron pipe of 6 to 4 in. diameter, with 13 fire hydrants, 10 gates, 6 meters and 75 taps. Service pipes are of wrought iron. The town pays $1,300 yearly for hydrants. Some spiral riveted wrought iron pipe was used in the distribution, but did not prove satisfactory.

The population, in 1880, was 1,232; it is now said to be 2,000.

The works have cost $22,000. The capital stock of the company is $25,000, and the bonded debt is $10,000 at 8 per cent. The works were completed Dec. 8, 1883.

C. M. Holmes is President of the company and W. O. Hutchinson, Secretary.

DCLXVIII., UNIONTOWN, PA.,

Uniontown Pennsylvania, in lat. 39°-53 'N., long. 79°-40′ W., is in rolling country, on Redstone Creek, and is the country seat of Fayette Co.

It was incorporated a borough in 1783. Water-works were built in 1883, by a private company, after plans of C. W. Knight, the supply being taken from springs, and delivered into the mains by gravity.

Distribution is by 6½ miles of cast-iron pipe of 8 to 4 in. diameter, with 38 fire hydrants. Service pipes are of lead.

The population in 1880 was 3,265; it is now said to be 5,000. The capital stock of the company is $50,000.

No further information is given.

C. H. Seaton is Superintendent.

DCLXXIX, YANKTON, DAK.

Yankton, Dakota, in lat. 42°-45 N., long. 97°-30 W., the capital of Dakota Territory, is on the north bank of the Missouri River on a smooth plateau, surrounded on the north and west by high and regular slopes.

Settled in 1856, it was first incorporated in 1869, and reincorporated a city in 1873. Water-works were built in 1883 by the city, after plans of Ed. Palmer, the supply being taken from an artesian well of 6 in. diameter, and 535 feet deep, flowing 86,000 gallons in 24 hours to a reservoir holding 120,000 gallons, constructed 130 feet above the city.

Distribution is by 2 miles of Wyckoff wooden pipe of 10 to 4 in. diameter, with 12 fire hydrants. No service connections have as yet been put in.

The population in 1880 was 3,431. The works have cost $20,000. The bonded debt is $18,000, at 7 per cent. The works are managed by the City Council.

Ed. Palmer is Superintendent.

DCLXXX, CLEBURNE, TEX.

Cleburne, Texas, in lat. 32° 25′ N., long. 97 20′ W., the county seat of Johnson county, is situated on the high rolling prairie between the Brazos and Trinity Rivers.

Water-works were built by the city in 1883-4, after plans of G. C. Heron, C. E., the supply being taken from a number of springs, the water from which is collected by vitrified drain pipe into a pump well 26 ft. in diameter and 26 ft. deep, walled in and covered with brick laid in cement, and is thence pumped by two Worthington pumps, one a compound duplex, of 16 in. steam and 10½ in. water cylinders and 10 in. stroke, and the other of 16 and 10 in. steam and 8½ in. water cylinders and 10 in. stroke, lifting 75 ft. to a wrought iron tank 20 ft. in diameter and 25 ft. high, supported by rolled iron beams on a brick tower 51½ ft. in height, the walls of which are 24 in. thick. By direct pumping a fire pressure of from 80 to 150 lbs. is obtained.

Distribution is by 5 miles of lap welder wrought-iron, kalamene coated pipe of 10 to 4 in. diameter laid with the converse lock joint, with 30 fire hydrants. The works have just been completed and no service connections are in use.

The population in 1880 was 1,855, it is now said to be 4,500. The works have cost $51,000. The bonded debt is $51,000 at 7 per cent. No Superintendent has as yet been appointed.

DCLXXXI. TYLER, TEX.

Tyler, Texas, in lat. 32° 20′ N., long. 95° 15′ W., the county seat of Smith County, is in a rolling hilly country at the head waters of the Neches River. Settled in 1847, it was incorporated a village in 1851 and a city in 1870.

Water-works were built in 1883, by the city, after plans of J. A. Jones, but before their completion they were sold to a private individual, he assuming the payment of the city water debt and completing them. The supply is taken from a number of springs, the water

from which is collected in an artificial pond, formed by earth dams with a puddle core 3 ft. wide, and is thence pumped by a duplex high pressure Worthington steam pump, lifting 100 ft. to a plate iron tank 24 ft. in diameter and 22½ ft. high, standing on a brick tower 24 ft. square, with foundation walls 7 ft. thick, the walls of the tower are 3 ft. thick and 50 ft. high. The tank has a capacity of 82,000 gallons and its extreme height above the business portion of the city is 119 ft. By direct pumping a fire pressure of 140 lbs. can be maintained.

Distribution is by two miles of cast-iron pipe of 8 to 4 in. diameter with 15 fire hydrants, 6 gates and 50 taps. The city pays $12 yearly for hydrants. Service pipes are of iron and lead.

The population, in 1880, was 2,423, it is now said to be 6,000. The daily consumption, in 1883, was about 80,000 gallons.

The cost of the works has been $34,500. The bonded debt is $34,000 at 7 per cent. for twenty years.

M. L. Brown is the owner and general manager, and Thos. Brown, Superintendent.

WATER.

LINCOLN, Neb., has recently purchased 1200 tons of water pipe.

ANOTHER artesian well at Council Bluffs has struck flowing water at a depth of 915 feet.

THE city of New London, Conn., will spend $3,500 for a new fire engine. The mains of the city system of Water Works have been extended along the Fort road.

THE new reservoir of the Yankton, Dak., Water Works is nearly completed. It will add 3,000 barrels to the storage capacity of the works and give a good reserve for fire purposes.

THE contract for laying 600 ft. of 4 in. pipe on Porter Street, Pittsburgh, was awarded to C. Howard & Son at 22 cts. per foot, and 600 ft. of 4 in. pipe on Liberty Ave. to the same parties at 39 cts. per foot.

ASHLAND voters have decided to pay an annual tax of $4,000 for rental of forty hydrants from the Holly Water Works company. Which is about to put in a system of Water Works in the city to cost $65,000.

A TRIAL of a new Worthington pump purchased recently by the city of Lancaster, Pa., was most satisfactory, 2,142,898 gallons being delivered in seven hours and forty minutes, an excess of 11.2 per cent. over the stipulated capacity of 6,000,000 gallons per day.

EAU CLARE, Wis., will have to do without Water Works for a while yet. The council effectually killed the Water Works ordinance by striking out the enacting clause. Petitioning tax payers, to the number of about 400, thought they saw a very large job for the contractors, and entered protest.

THE Common Council of Newaygo, Mich., has awarded the Michigan Pipe Co. the contract for furnishing and laying the pipe for the Water Works at that place. The sizes to be used are 8", 6" and 4", with eleven double fire hydrants. Mr. Walker's proposal to furnish the pumping machinery was accepted.

PITTSBURGH is becoming somewhat interested in the subject of the contamination of its water supply, the Allegheny and Monongahela rivers, by sewage; the improvements at Davis Island for the benefit of navigation having rendered the current of these streams more sluggish. In the opinion of engineers there is as yet little danger, however.

DURING August, 11,785,248 gallons of water were pumped by the water-works of Duluth, Minn., a daily average of 380,169 gallons, at an average pressure of ninety-one pounds on the mains. To accomplish this result fifty-nine tons of coal were used and the pumps were run 400 hours. During July 12,577,280 Galls. were used which was the largest consumption since th works were started.

THE franchise for twenty-five years of the Belleville, Ills., Water Works has been granted to E. F. Fuller, of the firm of Lockett & Fuller, C. E., Jersey City, who will commence work in sixty days. Water will be pumped from a storage reservoir into a standpipe. Distribution through pipe 14" to 4". There will be 100 hydrants. Estimated cost about $125,000. Messrs. Lockett & Fuller are the engineers.

NEW YORK, Sept. 9, 1884.

DEAR SIR:—In ENGINEERING NEWS of recent date, under "DLXXIX. Council Bluffs, Ia.," you have misstated size and kind of our pumping engines. There are two *Compressed Condensing Duplex* Pumping Engines, each having 16" H. P. steam cylinders, 30" L. P. steam cylinders, 16" water plungers and 24" stroke. Please correct and oblige. Very truly yours,

KNOWLES STEAM PUMP WORKS.

THE bids for 24 in. cast-iron water pipe to be laid across the Monongahela at Pittsburgh ranged from $24.41 per ton, by A. H. McNeil & Co., of Burlington, N. J., up to $28.20 by R. D. Wood & Co., of Philadelphia. Bidders for laying the same were Stoxenbach, Pheil & Co. at $1.32 per ft. in the streets, and $13 per ft. across the river. Booth & Flinn, at $1.24 per foot for laying the pipes in the street, and at $11.85 per foot across the river. The entire extension of the city water to the South side is estimated to cost $200,000.

NEWS OF THE WEEK.

Railroads and Canals.

AN effott is being made to enlist capital in the support of a projected road from Springfield, Ill., through Effingham to Mount Carmel.

IT is stated that the building of six thousand miles of new railroad in 1885 is contemplated, and that contracts for steel rails, etc., are now being made.

THE last spike in the L. N. O. & T. Road was to be driven on the 5th of September at a point 115 miles south of Memphis.

EL OBERO, of Pachuca, Mexico, recommends an extension of the Hidalgo Railroad toward the west and curving so as to reach Actopam and Ixmiquilpam.

THE survey of a railroad from Lansing, on the Cincinnati Southern, to Sparta has been completed, and right of way is being secured.

THE Illinois Southern and Paducah wants $150,000, for the favor of going out of its way to call on the town of Chester, Ill.

MR. SYKES, of the Chicago and Northwestern railway, says that the Fremont, Elkhorn and Missouri Valley company have authorized an extension of ninety miles west.

THE Shell Beach Road, in Louisiana, will build a road from Poydras Station, on the main line, to Pointe-a-la-Hache, a distance of about forty miles.

A CORP of engineers are making surveys, commencing at the Vicksburg and Meridian Railroad shops and going through the valley, coming out to the Mississippi River at a point a short distance above the Refuge Oil Mills.

THE tracks of the Catonsville short line have been laid as far as Gen. John Gill's, about three miles from Baltimore and a mile from the terminus at Catonsville. It is expected that the remaining distance will be completed in a month.

THE St. Louis cable road is to have all the improvements covered by the Philadelphia patents, which are an improved slot, the chief feature of which is that it will not break under the wheels of heavy vehicles, and an improved conduit or tunnel.

THE Board of Directors of the San Antonio and Aransas Pass Railroad have determined to immediately put the surveying parties in the field, one on each side of the river, and have authorized the Executive Committee to employ a competent engineer.

CADIZ, OHIO, September 7.—The corps of engineers, consisting of eleven men, surveying the Cadiz route for the Mount Vernon, Coshocton and Wheeling Road (Cannon Ball Line), are now at work examining the summit near here. They expect to reach Wheeling some time this month. A careful and accurate survey is being made.

PUBLIC WORKS IN ITALY.—Between 1862, the date of the unification of the budgets of the Goverment of Italy, and 1883, the Italian Ministry of Public Works expended 46,740,621*l.* for railways, and 30,821,709*l.* for roads, water supply, harbour improvemente, etc. The amount voted by the Italian Legislature for further public works in 1883 was 7,959,607*l.*

A NEW road is under discussion by the people of Monroe, La. The road is to run from Marianna, Ark. through the towns of Bastrop Monroe, Pineville, and Alexandria, La., to New Orleans over the New Orleans Pacific Road from Alexandria. With the Iron Mountain Road from St. Louis, this route would be the shortest to New Orleans by 200 miles.

SHENANDOAH, Sept. 4.—About 4 o'clock this afternoon the main branch of the Lehigh Valley Railroad, about one mile outside of town, sank about two feet. A West-bound passenger train had just passed when the ground gave way. All traffic is suspended, as the split extends a distance of 150 yards through the middle of the track, and at some places is four feet wide. A large force of men are at work filling up the road.

THE Minneapolis and Pacific Railway Company is the name of a corporation in which Henry T. Welles, William Washburn, Clinton Morrison, John Martin, Thomas Lowry, J. K. Sidle and J. C. Oswald, all of Minneapolis are stockholders. With a capital of $5,000,000 it is proposed to build and operate a railroad from Minneapolis in a northwesterly direction to some point on the Red River of the North, between the State of Minnesota and Territory of Dakota, between Breckenbridge and Brown's Valley.

CANADIAN RAILWAY PROGRESS.—According to recently issued official statistics, 1275 miles of railwas were built in Canada last year, making a total of 8805 miles under traffic. When the line at present under construction are completed, which will be within two years, the railway system of Canada will comprise over 11,400 miles. The paid-up capital was increased last year to $494,271,264, or 19 per cent. The gross revenue collected during the year was $33,244,585, an increase over the preceding year of $4,216,796.

VICTORIAN RAILWAYS.—The Victorian Minister of Railways is now receiving deputations, almost weekly, urging local claims for railway construction, in view of a Bill promised for next session. The most important of the deputations has been one urging the making of a line through South Gippsland to Port Alberton, which would, among other advantages, open up a direct reciprocal trade with Sydney. Mr. Gillies promised that the proposal should be throughly explained and all that could be urged for it laid before the Victorian Cabinet.

THE Huntington system of railroads is now practically complete. The Chesapeake and Ohio system now extends from Newport News, Va., to Memphis, Tenn., 1120 miles; the Southern Pacific is in operation from New Orleans to San Francisco, 2495 miles, and the intervening gap of 455 miles from Memphis to New Orleans is now closed by the Louisville, New Orleans and Texas Railway, under which name have been consolidated the Tennessee Southern Railroad, New Orleans, Baton Rouge, Vicksburg and Memphis Railroad, and New Orleans and Mississippi Valley Railroad. The total length of the line from Newport News to San Francisco is 4070 miles.

THE Morris & Southwestern Railroad company recently filed their articles of incorporation. The proposed road will start from Morris, and thence running southwesserly to some point on the Union Pacific railroad, in the state of Nebraska, between Columbus and Kearny Junction, in same state, The principal place of business will be Duluth. The capital is $10,000,000, divided into 100,000 shares of $100 each, The greatest amount of indebtedness is limited to $10,000,000. The incorporators are A. J. Sawyer, A. M. Miller, J. C. Hunter aud W. W. Spaldind, of Duluth, and W. D. Cornish, Crawford Livingston and Harlan P. Hall, of St. Paul. The preliminary survey is underway.

THE Florida Ship Canal and Transit Company which was incorporated with such a flourish two years ago seems to have emerged at that end of the historic horn whose cross section can only be e pressed by the aid of infinitesimals. The nominal assets thereof, which are advertised at sheriff's sale in settlement of a claim of $1700, for services rendered, brought by Mr. J. Francis Le Baron C. E., are as follows: 1 3-seated spring wagon with top; 1 U. S. Standard Hydrometer, in box; 1 Bycrometer, in case; 2 Brarometers, in cases; 1 Stackpole Sextant, in case; 1 Artificial Horizan, in mahogany case; 5 lbs. quicksilver; 2 mosquito nets; 1 rubber blanket; 1 net in hammock; 1,060 feet log line with log; 1 20-fathom sounding line; 2 pair saddle bags; 2 camp stools; 2 shovels; 1 box freezing mixture; 1 ax; 1 saddle; 1 map of Florida; 2 tubs; 1 water cooler; 1 stove pipe; 1 small table; 1 bureau 1 pitcher and bowl; 1 lamp, etc.

NEW ZEALAND RAILWAY PROGRESS.—The project of the construction of a railway to connect Auckland with the lake district of the north island of New Zealand, which has been subject to many disppointments, is now in a fair way of consummation. By Christmas the line will be constructed from Morrinsville, where it joins the Government railway, to the extremity of the Patetere block. From there to Ohinemutu the railway will be made under a Railways Construction Act, under which the Government gives blocks of land in aid. The agreements could not hithrto be completed, as the Government had not acquired the necessary lands from the natives. There is now, however, a fair prospect that this will be done within a short time, so that the construction of the line may be pushed on to Rotorua. The railway will open up an enormous extent of fertile country, and will greatly increase tourist traffic to the springs of Rotorua and the remarkable terraces of rotomahana.

THE projectors of the new Brooklyn Horse Railroad from Greenpoint to Prospect Park, have reached the point where the consent of the Aldermen is the next thing.

THE work on the narrow gauge railroad between the east end of the Hoosac Tunnel and Readsboro' City, projected by the Newton Brothers of Holyoke, has been hurried rapidly till of late. Now they are going more slowly. An engine and gravel train now run as far north as Monroe's Bridge, some seven miles. On account of the heavy grades and the large trestles, it is probable that the railroad will not be completed this year. The work will continue till about three and a half miles from the terminus at Readsboro' City, and then will stop till next summer.

Miscellaneous.

SINCE the completion of the Rush Street Bridge, there has arisen a demand for more double bridges in Chicago.

THE contract for raising the Tallapoosa has been awarded to the Merritt Wrecking Co. She is to be delivered at Brooklyn, N. Y., for $35,000.

THE bids for furnishing cement for work on the Iron Harbor, on Muskingum River, and for harbor improvements on the Monongahela River have all been rejected.

THE New Orleans Auxiliary Sanitary Association has petitioned the city that $8,000 be appropriated for the completion of the Touluose drainage canal, upon which $40,000, has already been expended.

THE Engineer's report upon the improvement of rivers and harbors in Oregon and Washington Territory, for the past year, shows amount available for the current year, $493,000, and amount asked for next year $1,928,000.

THE contractors for the new Court House at Pittsburg will be required to give bond for $500,000, and a penalty of $50 a day will be exacted for every day of delay beyond the time of completion specified in the contract.

OPERATIONS at the United States Arsenal at Watertown are very brisk at the present time. A dozen or more smiths at the forges are assisted by forty or more strikers, and all are engaged in turning out gun carriages and other new work.

THE following proposals were received for rebuilding the Cambridge (Mass.) Street Bridge: W. A. Kenrick, $4,943; Alexander McInnis, $4,249.95; W. A. Norton, $6,000; J. P. Perkins & Son, $4,721.40; Young, Ryan & Hayes, $4,999.99. The contract was awarded to Mr. McInnis.

THE leak which was discovered in the dam across the Connecticut River, at Holyoke, proves to be much more serious than was first supposed and is thought to be growing in size. The large crib was sunk but appeared to have but little effect on the leak. A large number of sand bags have also been sunk but the leak remains as yet unstopped, and most of the paper mills in Holyoke are stopped.

BLACK RIVER HARBOR.—The following is an abstract of the proposals for repairs to piers, at mouth of Black River, Ohio, opened by Major Overman, August 26: Daniel M. Averill, Cleveland, Ohio, $6,981.57; Charles A. Sturdevant, Lorain, Ohio, $6,696.69; John Stang, Lorain, Ohio, $6,216.90; L. P. & J. A. Smith, Cleveland, Ohio, $6,431.67. The contract has been awarded to John Stang.

THE following is an estimate of cost for rebuilding the Carrollton levee, La. With a length of 6500 ft., a levee with 78 ft. base, 13 ft. high, with a crown of 12 ft. and a slope inside of one to two would, if the dirt could be obtained on the spot, cost twenty-three cents a cubic foot or $28,500. Should it be found necessary to cart the earth, the cost would probably be $1 per yard, which would in consequence more than double the cost of the levee.

THE amount of geodetic work already accomplished by the United States Survey in Pennsylvania is as follows: Fifteen bases have been measured with accuracy; 10,522 triangulation stations have been occupied; 183 stations have been established for azimuth, 296 for latitude, 110 for telegraphic longitude and 664 for magnetic observations. The reductions have received equal attention to field work. The special publications are: 19 on base apparatus and measurements; 22 on field work and reduction of triangulation; 8 on azimuth, 11 on latitude, 71 on longitude and 4 on geodetic leveling. The working force of the survey consists of officers of four ranks, with admission by appointment to the lowest and promotion in accordance with tenure of office and experience to each higher rank in succession.

A CONTRACT has been awarded to Messrs. Gorman & Wilson, of Vicksburg, for the building of piers and constructing false work of the new iron bridge to be built over the Big Black River by the Louisville, New Orleans & Texas Railway. As the road crosses the Big Black now on a curve, the management of the road have decided to make the road run on an air line across that stream. The bridge will be made of three spans. The centre one will be 150 ft. and the shore spans 75 ft. each. It will require 100,000 ft. of lumber to construct the false work on this bridge.

A CLAIM of twenty-five years' standing for work done in the construction of a railroad has been made by Michael Hayes in Common Pleas Court No. 1, in the shape of a bill in equity filed against the Bald Eagle Valley Railroad Company, Pennsylvania Railroad Company as lessees, and the Fidelity Trust Company as mortgagee. The plaintiff avers that for several years prior to 1859 he was one of the contractors for the construction of the Tyrone and Lock Haven Railroad Company, and that in March of that year there was owing to him over $20,000. That in 1850 the road made a mortgage for $500,000, which was foreclosed a year later, when the road was sold to Philip M. Price for $21,000. He reconstructed the road as the Bald Eagle Valley Railroad Company, and in 1864 effected a lease to the Pennsylvania Railroad Company for ninety-nine years. In January 1880, a mortgage for $400,000 was executed to the Fidelity Trust Company. The plantiff asks that the books and accounts of the Tyrone and Lock Haven be produced, that an account be stated, and that the Court order payment to be made to him of the balance found to be due.

MAJ. GEO. H. SIMPSON, of LaGrange, Mo., has secured a contract from the Government to furnish between 20,000 and 30,000 yards of stone for the construction of a dike across the "chute" between Long Island and Oyster Island, opposite St. Louis. Work has been commenced at a quarry about two and a half miles above this place, in the Mississippi bluffs, known as Wolfmier's quarry. One hundred men and twenty teams will be employed, and from 400 to 500 yards of "riprap" will be taken out every day.

Isadore Mantz, of Keokuk, Ia., also has a contract for supplying 23,000 yards of "dimension stone" for Government locks and canal on the Des Moines Rapids, of the Mississippi, above Keokuk. The stone will be obtained from Wolfmier's quarry.

Three small steamers and one dredgeboat have been employed for a month past under the supervision of Capt. Thompson, of New York, United States Engineer, dredging off the gravelly bar at the mouth of the Wyaconda River, just above LaGrange. This bar has been a serious obstruction to navigation. The improvement made by the Captain is already perceptible. A portion of the gravel raised by the dredgboat is being used in the construction of a wing dam jutting out from Long Island, about four miles above the mouth of the Wyaconda, and also on the dike between Long Island and Oyster Island, below the Wyaconda.

THE bridge across the Harlem River at 126th street near Second Avenue, of which brief mention was made in this column last week, is being erected by the Suburban Rapid Transit Company, under the direction of Mr. J. J. R. Croes, their Chief Engineer. The five piers of cut stone masonry and concrete will be completed in October. They are about 60 feet high, and are founded on timber platforms resting on the gravel which underlies the river bed At the site of one of the piers, the dredging developed a bed of quicksand, rendering it necessary to pile the foundation. The bridge will have two railroad tracks and two footwalks, and there will be a clear headroom for boats, of 28.7 feet at mean high water. The railway will connect at 129th street with the Manhattan Elevated railway at Second and Third Avenues, North of the river; it will cross the depot grounds of the New Haven Railroad on iron trestle work, and proceeding Northward, traverse the 23rd and 24th wards to Jerome Park on one side and the Bronx River on the other. The routes and grades are so established as not to occupy any streets nor to cross any at grade. Mr. Croes when Engineer to the Park Department, in 1877, laid out the streets in this territory with a view to the construction of rapid transit road in this manner, and all the plans of the Suburban R. T. Road have been prepared by him. For the details of iron structures, he has engaged the services of Mr. Theodore Cooper, C. E., and the Harlem River Bridge and its approaches are expected to represent the latest and best practice in American iron bridge construction. The construction of the bridge is in immediate charge of Resident Engineer H. W. B. Phinney.

A NEW twin-screw hopper dredger, of 800 tons capacity, built and engined by Messrs. W. Simons & Co., was recently launched complete from their works at Renfrew. It is named the "Valencia," and is the property of the harbor authorities of Valencia, Spain. It has been constructed under the direction of the engineer of the port, Don A. de Lazaro. This is a sister dredger to the Espana, launched by this firm a few weeks ago. The Valencia is fitted with two separate sets of compound engines of 500 horse-power; it dredges to 35 ft. depth, and is fitted with the builders' patent traversing gear to cut her own way in shoals, and will raise 400 ton per hour. It carries 800 tons of its own spoil at a speed of ten miles per hour. These two duplicate hopper dredgers are intended to take the place of a large fleet of barges, tugs, and stationary dredgers on the old system which have been in use for many years.—Glasgow *Herald*.

Competition.

CITY OF KONIGGRATZ, BOHEMIA.

To Architects, Surveyors, etc.

Levelling Fortifications, Laying out Streets, Squares, etc., Main System of Drainage, and Rebuilding of Bridges.

The fortifications which surround the royal corporate City of Königgratz, in Bohemia, are to be demolished, and on the area of about 132 (Austrian) acres which will be gained by this demolition, besides on an area of 336 (Austrian) acres which is now comprised in the *enceinte* of the fortifications, a new town is to be erected. In order that the new town be built in the most satisfactory manner, so as to enjoy from the commencement all the advantages which can result from, in the first place, the topography of the district and country, and, in the second place, all the modern experience which has been gained in architecture, a public competition has been invited, based on two decrees of the Town Council of Königgratz—the first dated August 21, 1882 Article 9, and the second dated June 6, 1884, Article 10, under the following conditions:

1. Each competitor shall furnish four plans, two of the site and two showing the ground level, with full written explanation of the same.
2. Site plans must be drawn thus:
   (*a*) That the first represent the distribution of the whole superficial building area in squares, streets, building plots, etc., in a general view, on the scale of the cadastral map of 1:2880.
   (*b*) That the second represent a complete and detailed distribution of the building plots on the area of 132 (Austrian) acres gained by the demolition of the fortifications, as also on the free land which runs along the communications towards the railway station, on a scale of 1:1,000.
3. The site plans must not touch—
   (*a*) The side of the present city, the central point of which must not be displaced.
   (*b*) The existing bridges, quays, means of communication, and proposed means of communication.
   (*c*) The existing plans of the canal.
   (*d*) The division of the new town into a residential quarter and a manufacturing quarter, leaving sufficient space for public squares and grounds.
4. To these site plans must be added level plans on the same scale, giving a complete description of the height of the squares, streets, means of communication, etc.
5. It is especially required that these *niveau* plans contain:
   (*a*) A complete system of drainage for the lower parts of the town.
   (*b*) M ans of preventing inundations by the rivers Elbe and Adler.
6. It is also required that all plans—
   (*a*) Shall be in accordance with the requirements of both town and country.
   (*b*) Shall in all respects, and especially in respect of hygiene, be of the most approved modern description.
   (*c*) Shall be in accordance with the laws of Austria, and capable of being submitted for approval to the Government authority.
7. The written explanation which competitors must enclose is to be a briefly written description of the whole project, and at the same time must give a concise statement of the best means for putting the plans into execution.
8. It is likewise required that the description shall contain a report on the now existing bridges, and on the possibilities of removing the same.
9. It is requested that plans and specifications be sent in at or before 12 o'clock noon, on December 22, 1884, to the Burgomaster. Each set of plans must bear a mot'o, which shall be repeated on a sealed envelope containing the name and address of the sender of the accompanying plans.
10. The three plans which most correspond to the given conditions, and are considered the best by the jury then to be named, shall receive—
   (*a*) First prize of 2,000 florins.
   (*b*) Second prize of 1,500 florins.
   (*c*) Third prize of 1,000.

The plans to which the said prizes have been awarded shall become the complete and absolute property of the City of Königgratz.

11. All further particulars for the purpose of the above competition may be seen during business hours at the office of the Burgomaster in Königgratz.

Copies of all necessary particulars, including geological plan of the city, plans of the fortifications to be demolished, of the site of the existing town and plan of the country, the high-water mark of the rivers Elbe and Adler, of the existing canal, with a graphic representation of the tidal level, and, lastly, plans for the construction of the whole of the proposed works, will be sent to any part on receipt of the sum of thirty florins.

The Burgomaster,
(Signed) COLLINO.

Office of the Burgomaster, Königgratz:
June 22, 1884.